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Western Newspaper Union Plant in Chicago

By Thomas Wilson

SYNOPSIS—Moving an isolated plant having 525 hp. in boilers and 400-kw. generating capacity while maintaining the service. The operating cost is less than central-station service. An analysis of the plant.

In the summer of 1910 the Western Newspaper Union, which does a general printing and manufacturing business on a large scale, moved into a new building at the corner of Adams and Clinton St., Chicago. In plan, the building measured approximately 125x125 ft. and was eight stories high above the street level. Practically the entire floor space was occupied by the company, and as power was required night and day for the presses, steam for manufacturing and heating, and current for lighting, a private plant was installed.

For three years the plant gave a good account of itself, but late in 1913 the building site was purchased to form part of a tract on which to erect the new Pennsylvania station. As the building was to be torn down the mechanical equipment was moved to a building at Desplaines and Adam St. The latter is five stories high, but as it measures 150x165 ft., the floor space and cubic contents are nearly the same as for the building first occupied.

Past Records Favor Isolated Plant

As is common at such times, strenuous efforts were made by the central station to get its service into the new building. With the printing company it was a question of

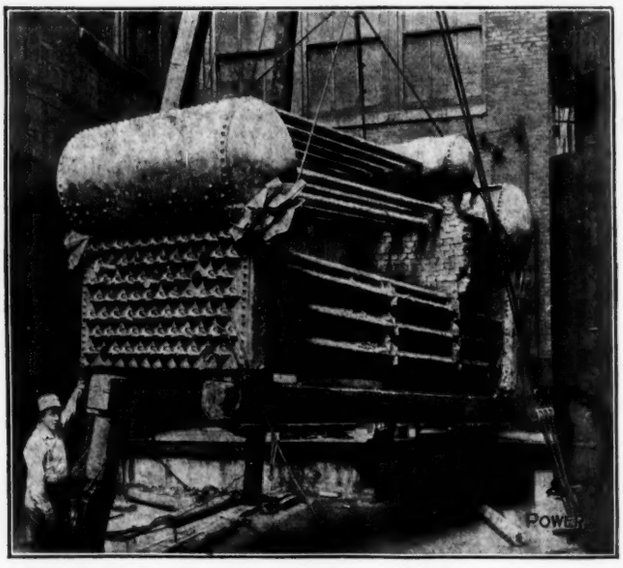

Fig. 1. Moving One of the Water-Tube Boilers

disposing of the generating equipment and accepting the rates offered or moving the plant and continuing to generate its current; this question was thoroughly discussed. Records for three years were available from which to determine the average loads and the cost of operation. Using the rate quoted by the central station, it was an easy matter to obtain an accurate comparison. The figures are not available, but as the station equipment is now being moved, of course, the results favored the isolated plant. Factors influencing the decision were twenty-four-hour service seven days in the week, the use of all exhaust steam for heating except during peak loads and in the summer months, and a demand for steam at 60 lb. pressure in the manufacturing processes. It was seldom

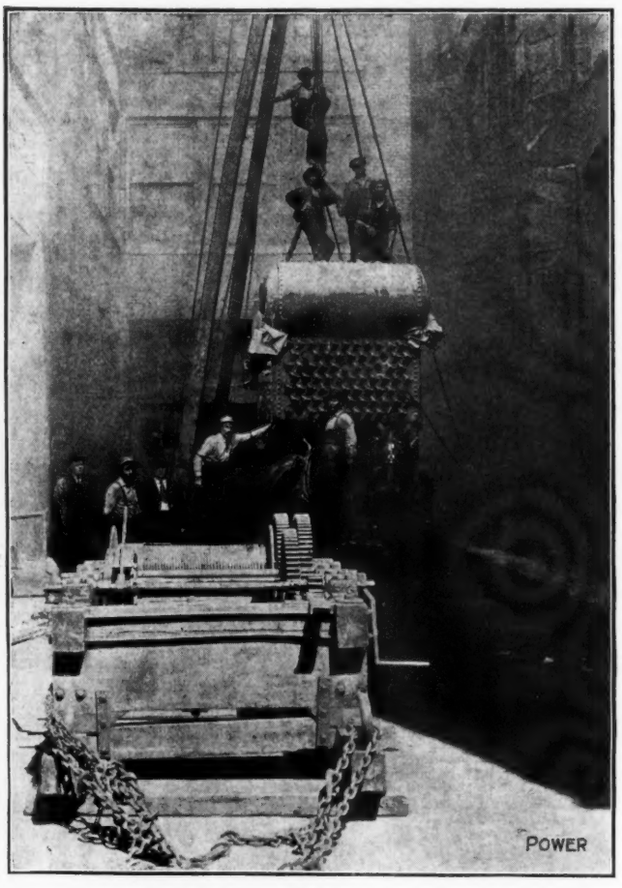

Fig. 2. Hoisting a Boiler onto a Wagon

that live steam was needed to supplement the exhaust, but on the coldest mornings of winter it was used to a limited extent to help heat up the building.

Briefly, the plant equipment consists of three 175-hp. water-tube boilers with extension furnaces and coal-handling equipment, the usual pumps, and in the engine room three direct-current generating units, one rated at 200 kw., a second at 125 kw. and the third at 75 kw. There are four tandem-gear electric elevators, two for passenger service, with a carrying capacity of 2500 lb. at a speed of 250 ft. per min., and two 5000-lb. freight elevators designed for a speed of 150 ft. per min. For freight there is also a 2000-lb. sidewalk lift. A two-pipe vacuum heating system with 16,000 sq.ft. of radiation was put in the building.

Moving the Plant

The above was the power-plant machinery which had to be moved, and to accomplish it without interrupt-

ing the service it was necessary to work on Saturday nights and Sundays, when the load was lighter than usual. The equipment was moved a unit at a time and put into operation in the new building. At the present writing more than half of the printing and power-plant machinery has been transferred and is in operation. Two boilers, the largest and smallest generating units and the switchboard have also been moved. It is intended to complete the work very shortly. A temporary switchboard, one boiler and the 125-kw. unit keep the old plant in operation. As a safeguard, breakdown emergency service has been installed. Due to careful planning and working to schedule, the plant has not lost any time to the company.

For moving, the smaller apparatus and generating units were dismantled and then conveyed by wagon to the new site. Wagons also transported the boilers, but as each weighed 34,000 lb., the task was more difficult. After a boiler had been disconnected, the settings knocked down and the furnace removed, it was placed on blocks and skidded under an opening in the driving court provided for the passage of machinery. By means of a derrick over the opening having the usual block and tackle and operated by a winch, the boiler was hoisted onto the wagon, and in much the same way, only with the operations reversed, it was lowered into the new plant. Figs. 1 to 3 will tell the story.

FIG. 3. ON THE WAY TO THE NEW PLANT

BOILER ROOM OF THE NEW PLANT

Fig. 4 shows the layout of the new plant, which differs somewhat from the old, although the installation contains the same machinery. In the Dec. 20, 1910, issue of POWER the older plant was described, but as the arrangement differs and additional data are available, a short analysis of the design may be of interest.

In the present plant two of the boilers will be arranged in a battery and the other set singly. Each has 1740 sq.ft. of heating surface and is equipped with a stoker having 33 sq.ft. of grate surface. The ratio is 53 to 1. The operating pressure is 150 lb. gage, although the boilers were designed for 180 lb. At the boiler farthest from the stack, the breeching is 3 ft. wide by 6 ft. high and is widened to 5 ft. at the second boiler, giving an area of 30 sq.ft. The brick stack is 5 ft. in diameter and is 150 ft. above the grate line. Its sectional area is 19.635 sq.ft. To the connected grate surface this area bears a ratio of 1 to 5, a good average figure for Western coal, and for every horsepower of boiler rating there is 0.037 sq.ft., or 5.3 sq.in. of stack area. The breeching dimensions are liberal, as the ratio of breeching area to connected grate is 3 to 10 and of breeching to stack area 3 to 2.

As in the old plant, a damper regulator will be arranged to control the dampers and at the same time the speed of the stoker engines, so that the supply of coal to the grates will be regulated according to the load conditions. When first set up the boilers developed an efficiency of 70 per cent. with coal averaging 11,150 B.t.u.

It is the intention to have complete coal-handling apparatus. Coal is dumped into a bunker, 20x75 and 20 ft. high, under the driving court. It will be carried by wheelbarrow to the boot of an elevator leg delivering to a one-ton traveling and weighing hopper over the furnaces. At present the coal is wheeled from the bunker to the furnaces. A revolving soot blower facilitates cleaning and the ashes will be removed by a bucket elevator rising to the street level and spouting to wagons.

The source of water-supply is the city mains. In winter the returns from the heating system with sufficient make-up is passed to a closed heater having a capacity of 16,000 lb. of water per hour. It is handled by either one of two 7x4½x10-in. duplex pumps, when exhaust

steam is needed for heating, and by a 4x6-in. triplex motor-driven pump in the summer months; the latter is naturally more economical of steam. The three pumps are to be so interconnected that any one of them can be used for boiler feed or house purposes. Connection from the pumps will be made to a manifold at the side of one of the boilers, from which point the feed will be controlled. There will also be a city water connection so that the boilers may be filled conveniently after being washed out.

Engine Room

Here the three generating units are arranged as shown in the plan view. The large 200-kw. machine is an angle compound, 17 and 28 by 14 in., running at 260 r.p.m. The other two units, 125 and 75 kw., are driven by simple horizontal engines with cylinders 16x16 in. and 14x12 in. in the order of their size. The speeds are 240 and 275 r.p.m., respectively. Direct current at 230 volts is generated, and duplicate compensating sets, each of 15-kw capacity, will supply lighting current at 115 volts. Besides the elevator motors there is a connected motor load of 450 hp. made up of 175 motors ranging in size from ⅛ to 40 hp. In the old plant—the load conditions will be practically the same in the new building—the compound unit carried the load during the day, with some help from the 75-kw. machine during the peaks. The latter carried the load at night and the 120-kw. unit was held as a reserve.

Piping

The arrangement of the piping is shown in Fig. 4. From each boiler 6-in. pipes lead into the top of an 8- and 10-in. header which delivers to a secondary 10-in. header in the engine room supplying the three units through 7-, 6- and 5-in. pipes in the order of their size. A 3-in. pipe to the auxiliaries taps the boiler-room header and there is also a couple of connections to supply live steam at reduced pressure to the heating system and the feed-water heater. The exhaust pipes from the engines rise at each unit and eventually join overhead in a 12-in. pipe leading to the heater, the heating system and to the atmospheric exhaust. The location of the valves and the subdivision of the piping will be apparent in the plan view.

It may be of interest to determine the sectional area of the steam pipes per unit of boiler and engine rating and the velocities in the engine supply and exhaust piping. A 6-in. pipe from each boiler allows 0.165 sq.in. per boiler-horsepower. If the boiler were delivering steam at its full rating

$$175 \times 30 = 5250 \text{ } lb. \text{ } per \text{ } hr.$$

or 87.5 per min., would be delivered. At 150-lb. gage pressure this weight of steam would occupy

$$2.758 \times 87.5 = 241.33 \text{ } cu.ft.$$

and the velocity in feet per minute through the pipe would be

$$241.33 \div 0.2006 = 1203$$

For the engines the following sectional areas of piping for the supply and exhaust have been allowed per kilowatt of rating: 200-kw. unit, supply 0.1937 sq.in., exhaust 0.3943 sq.in.; 125-kw. unit, supply 0.2311 sq.in., exhaust 0.3099 sq.in.; 75-kw. unit, supply 0.2667 sq.in., exhaust 0.3852 sq.in.

To arrive at the approximate velocity of the steam in the piping, assume an average operating rate of 40 lb. per kilowatt-hour for the compound engine and 50 lb. for the two smaller machines. At full load the compound engine would use 8000 lb. of steam per hour, or 133 lb. per min.; the 125-kw. machine 6250 lb. per hr., or 104.2 lb. per min., and the smallest unit 3750 lb. per hr., or 62.5 lb. per min. At 150 lb. gage the volumes of steam passing per minute in the same order would amount to 368, 287 and 172 cu.ft. The velocity of the steam supply in each would then be 1366, 1431 and 1241 ft. per min.,

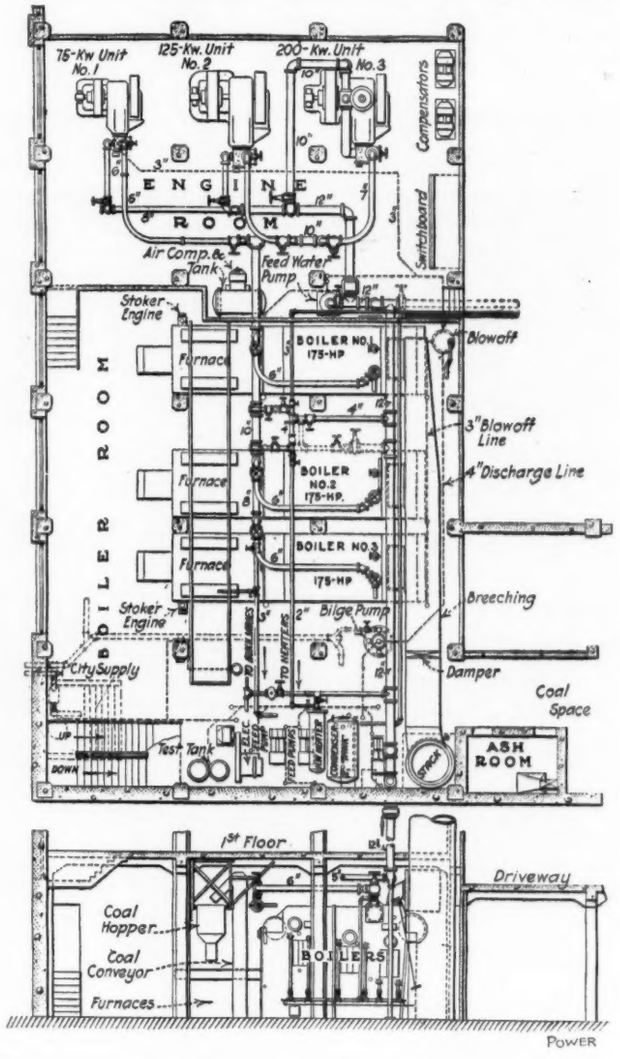

Fig. 4. Plan of Piping and General Layout of the New Plant

assuming, as is usual, that the flow is continuous throughout the stroke. These velocities average 1346 ft. per min. as compared with 6000 ft., the average for current practice. It is evident that the sizes of the supply pipes are liberal, but at the time the plant was installed it was the practice to use large piping and relatively low steam velocities. It must be remembered that with a small receiver the steam flow would be intermittent and the velocity during admission would be practically four times as great as previously indicated. Sudden and heavy overloads and the size of the openings into the cylinder also influence the size of the piping.

With the exhaust at atmospheric pressure, which would be the case in the summer months,

$$133 \times 26.79 \times 0.87 = 3100 \text{ } cu.ft.$$

of steam per minute would be discharged from the 200-kw. unit. The 26.79 is the cubic feet in a pound of steam at atmospheric pressure and the 0.87 the quality of the steam after expanding adiabatically from 150 lb. gage to atmospheric pressure. As the area of the 10-in. pipe in square feet is 0.5476, the velocity of the steam would be

$$3100 \div 0.5476 = 5661 \textit{ ft. per min.}$$

Figuring in the same way, the 125-kw. unit would discharge 2428 cu.ft. of steam at a velocity of 9026 ft. per min. and the 75-kw. unit 1456 cu.ft. at a velocity of 7261 ft. per min. The average of the three exhaust steam velocities is 7361 ft. per min. This is a little above the usual velocity allowed in the exhaust piping of an engine, but a slight increase in back pressure or running below rating would reduce the volume and consequently the velocity of the steam.

Velocities in steam-engine piping are largely a matter of individual opinion. Since the advent of the steam turbine the tendency has been upward. In these days a velocity of 8000 ft. for the supply is not considered excessive. The exhaust velocity is usually limited to 4000 ft. to prevent friction in the piping and to hold down the back pressure.

Besides the equipment just enumerated there is an air compressor driven by a 20-hp. motor. The machine supplies 100 cu.ft. of air per min. at 100 lb. pressure for operating a pneumatic system, certain machinery in the printing and manufacturing plants and for cleaning the various machines.

PRINCIPAL EQUIPMENT OF WESTERN NEWSPAPER UNION PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Water-tube	175 hp	Generating steam	Mechanically fired; natural draft, 150-lb. gage	Atlas Water Tube Boiler Co.
3	Stokers	Top feed	5½x6 ft.	Boiler furnace	Mechanically operated	Model Stoker Co.
1	Coal elevator	Bucket	15 tons per hr.	Lift coal above furnaces	Motor driven	Jeffrey Mfg. Co.
1	Coal hopper	Traveling and weighing	1 ton	Weigh coal and feed to furnaces		Jeffrey Mfg. Co.
1	Ash elevator	Bucket	10x6-in. buckets	Hoist ashes to street level	Motor driven	Chain Belt Co.
2	Pumps	Duplex	7x4½x10-in.	Boiler feed	150 lb. steam	Platt Iron Works
1	Pump	Triplex power	4x6-in.	Boiler feed or house service	Driven by 7½-hp. motor	Deane Steam Pump Co.
1	Heater	Open	16,000 lb. per hr.	Heat boiler feed	Exhaust steam, water 208 deg.	The Griscom Russell Co.
1	Engine	Angle compound	17x28x14-in.	Main unit	150 lb. steam, 260 r.p.m.	American Engine & Electric Co.
1	Generator	Direct-current	200 kw.	Main unit	230 volts, 260 r.p.m.	American Engine & Electric Co.
1	Engine	Simple horizontal	16x16-in.	Main unit	150 lb. steam, 240 r.p.m.	American Engine & Electric Co.
1	Generator	Direct-current	125-kw.	Main unit	230 volts, 240 r.p.m.	American Engine & Electric Co.
1	Engine	Simple horizontal	14x12-in.	Main unit	150 lb. steam, 275 r.p.m.	American Engine & Electric Co.
1	Generator	Direct-current	75 kw.	Main unit	230 volts, 275 r.p.m.	American Engine & Electric Co.
2	Elevators	Tandem gear	2500 lb.	Passenger service	250 ft. per min., 40-hp. motor	Western Electric Co.
2	Elevators	Tandem gear	5000 lb.	Freight	150 ft. per min., 40-hp. motor	Western Electric Co.
1	Heating system	Two-pipe vacuum	16,000 sq.ft. rad.	Heat building	Exhaust steam	Warren Webster & Co.
1	Soot blower	Revolving type		Blow soot off boiler tubes		Vulcan Soot Cleaner Co.
1	Air compressor	Single stage horizontal	6x9½x10-in.	Compressed air for general use	100 cu.ft. per min. at 100 lb. pressure	National Brake & Electric Co.
1	Motor	Direct-current	20 hp.	Drive air compressor	220 volts, 860 r.p.m.	National Brake & Electric Co.

Water for drinking is doubly filtered and cooled. It passes through sand and paper-disk filters in series and is cooled in galvanized-pipe coils laid in an ice box. Bubbling fountains are distributed throughout the building.

For the new layout of the plant as well as the old, and for the moving, Charles G. Atkins, consulting engineer, is responsible.

Will Quizz, Jr.

SYNOPSIS—How Will got his first ideas of engineering, and later learns that faithful plodding does not necessarily bring large success. His conference with Chief Teller on this occasion was not of a technical character, but perhaps it was as vital as any.

"You know, Chief, a boy always has an ideal, and my ideal was to become an engineer like Heintz, the late chief engineer at the gas works.

"When I was a youngster I used to peer longingly through the engine-room window. Heintz would sometimes allow me in the engine room where I would sit in rapture watching the moving machinery—and Heintz. He was a veteran engineer, and my ambition was to be able to wield the long-spouted oil can like he did. You know my pet saying, 'Heintz would do it this way'—but did he do the best way?

"Since Heintz's enforced retirement, practically on charity, some of the dreams of my childhood have been shattered and I have serious doubts about it. Many good things are said about Heintz, but to me they have brought a flood of doubt. Do I want to follow in his footsteps? Heintz was a fine old character, and his whole career had been in the same engine room. His friends always had seen him in one of three places—at home, in the engine room, or on the path between the two. He worked every Sunday and every holiday; he never had a vacation—never received an increase of pay.

"I notice that his two sons are not following engineering. I am very much bothered as to whether I am on the right track for my life's work. What do you think, Chief?"

"I am glad, Will, that you have so much confidence in me, but it puts a grave responsibility on me too. Everyone has periods of doubt, and evidently you do not want to become an engineer of the Heintz class. It is unfortunate that so little encouragement is offered by some corporations and that there are men so situated or constituted that they will never rise above the lowest grade jobs in any line.

"It is entirely possible, however, for engineers to work reasonable hours, and for them to improve mentally, financially and socially. To avoid becoming disappointed after it is too late to make a change, exert yourself to acquire an engineering education. You will find that the greatest pleasure comes from improving your mind. Cut out those things which will surely leave you stranded and disappointed. You can fire boilers and run an engine and know next to nothing. You can't get on very far in that way. The only hope for a young man to escape the mediocre life is to educate and advance himself day by day.

"There are two elements of greater importance than

the trade or occupation—one is the boy (or man) and the other the opportunity or set of conditions surrounding him. When it comes to averaging the load factor of the whole lot of us it's going to be surprising to see how near the maximum some unassuming fellows have been operating with the equipment they had, and under handicaps or unavoidable circumstances of which others may have known nothing.

"I feel sure that you have the right stuff in you, son, to become an engineer worth while, but remember that there can be no excellence without great labor. You have my best wishes and are welcome to any help I can give."

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Test of 200-Hp. Gas-Producer Plant

By F. V. Larkin*

SYNOPSIS—Figures showing what may be expected of an anthracite suction producer of this size supplying a four-cylinder, four-stroke-cycle engine under full-load conditions.

During the autumn of 1913 the department of experimental engineering at Lehigh University was called upon to make an acceptance test of a suction producer supplying a 200-hp. gas engine, the object being to ascertain whether the manufacturer's guarantee of capacity, speed regulation and economy was being fulfilled.

TABLE 1. RESULTS OF GAS PRODUCER TEST

Duration of test	24 hr.
Kind of coal used	Anthracite pea
Height of the producer	9 ft.
Inside diameter	5 ft., 8 in.
Area of grate	25.2 sq.ft.
Air space in grate	29 per cent.
Area of water heating surface in vaporizer	70 sq.ft.
Rated capacity of producer in lb. of coal per hr.	250 lb.
Average Pressures and Temperatures	
Steam pressure in vaporizer	14 lb.
Gas pressure in main where measured, in. of water	0.985
Draft in ashpit, in. of water	0.102
	Deg. F.
Temperature of water entering vaporizer	166
Temperature of gas in main near producer	584
Temperature of gas where measured	59.7
Temperature of air in producer room	67.7
Temperature of water entering scrubber	53
Temperature of water leaving scrubber	112.9
Weight of dry gas per cu.ft. reduced to 62 deg. and 30 in.	0.066 lb.
Hourly Quantities	
Dry coal consumed per hour	206.8 lb.
Dry coal consumed per hour per sq.ft. of grate	8.2 lb.
Gas delivered per hour	14,628 cu.ft.
Gas per hour at 62 deg. and 30 in.	15,520 cu.ft.
Weight of dry gas per hour	1,032 lb.
Steam supplied to producer per hour	543 lb.
Water fed to scrubber per hour	2,164 lb.
Ultimate Analysis of Dry Coal	Per Cent.
Carbon (C)	79.21
Hydrogen (H)	2.01
Oxygen (O)	0.00
Nitrogen (N)	0.80
Sulphur (S)	1.32
Ash	17.37
Moisture in sample of coal as received	2.74
Analysis of Ash and Refuse	Per Cent.
Carbon	39.99
Earthy matter	60.01
Analysis of Gas by Volume	Per Cent.
Carbon dioxide (CO_2)	0.536
Carbon monoxide (CO)	26.760
Oxygen (O)	0.332
Hydrogen (H)	10.944
Marsh gas (CH_4)	1.007
Olefiant gas (C_2H_4)	0.051
Sulphur dioxide (SO_2)	0.000
Hydrogen sulphide (H_2S)	0.000
Nitrogen (N) by difference	61.370
Calorific Values of Coal, B.t.u. per Lb.	B.t.u.
(a) Dry coal by calorimeter	12,363
(b) Wet coal as fired by calorimeter	12,033
(c) Wet coal as fired by Dulong's formula	12,500
Calorific value per lb. of combustible	14,960
Calorific Value of Gas, B.t.u. per Cu.Ft. at 62 Deg. and 30 In.	
(a) By calorimeter	137
(b) By calculation	138.4
Economy Results	Cu.Ft.
Total cu.ft. of gas as calculated per lb. dry coal fired	70.7
Equivalent cu.ft. of gas at 62 deg. and 30 in. per lb. dry coal	75
Equivalent cu.ft. of gas at 62 deg. and 30 in. per lb. of combustible	104.6
Efficiency	Per Cent.
Efficiency of producer based on coal	83.1
Efficiency of producer based on combustible	95.7
Cost of Production	
Cost of coal per ton of 2240 lb. delivered	$3.25
Cost of coal to produce 10,000 cu.ft. of gas at 62 deg. and 30 in.	0.199
Cost of coal for producing 1,000,000 B.t.u.	0.1451
Heat Balance Based on 1 Lb. of Dry Coal	Per Cent.
Heat contained in dry gas	86
Heat carried away by scrubber	9
Heat unaccounted for, including radiation	5

*Assistant Professor of Mechanical Engineering, Lehigh University.

TABLE 2. RESULTS OF GAS ENGINE TEST

Duration of test	24 hr.
Make of engine	Fairbanks Morse
Type	Four-stroke cycle
Size	Four-cylinder 14½x18-in.
Method of ignition	Battery during test, ordinarily magneto
Rated capacity	200 hp. at 250 r.p.m.
Kind of gas (for analysis of gas, see producer test)	Mixed producer gas
Average Pressures and Temperatures	
Pressure of gas near meter, in. of water	0.985
Temperature of cooling water	Deg. F.
(a) Inlet to cylinders and valves	53.74
(b) Outlet from cylinders	114.56
(c) Outlet from valves	104.95
Temperature of gas near meter	62.3
Temperature of exhaust gases	1019.23
Gas consumed per hour at 62 deg. and 30 in.	15,520 cu.ft.
Cooling water supplied per hour	
(a) To jackets	9,000 lb.
(b) To valves	475 lb.
Analysis of Exhaust Gases by Volume	Per Cent.
Carbon dioxide (CO_2)	16.99
Oxygen (O_2)	1.84
Carbon monoxide (CO)	0.50
Nitrogen (by difference) N_2	80.67
Indicator Diagrams	
Pressure in lb. per sq.in. above atmosphere	
(a) Maximum pressure	300
(b) Pressure at end of expansion	25
(c) Exhaust pressure at lowest point	2
Average mean effective pressure in lb. per sq.in.	59
Speed and Explosions	
Revolutions per minute	239
Average number of explosions per min.	478.5
Indicated horsepower	211.8
Brake horsepower	199.2
Friction horsepower by difference	12.6
Percentage lost in friction	5.8
Economy Results	
Heat units consumed by engine per hour	
Per indicated horsepower	10,034 B.t.u
Per brake horsepower	10,674 B.t.u.
Gas consumed per hour	
Per indicated horsepower	73.3 cu.ft.
Per brake horsepower	78 cu.ft.
Dry coal consumed per i.hp.-hr.	0.98 lb.
Dry coal consumed per b.hp.-hr.	1.04 lb.
Cost per i.hp.-hr.	$0.00146
Cost per b.hp.-hr.	$0.00155
Efficiency	
Thermal efficiency ratio	Per Cent.
Based on i.hp.-hr.	25.3
Based on brake horsepower	23.8

Heat Balance Based on B.t.u. per I.Hp.

	B.t.u.	Per Cent.
Heat converted into work	2545	25.4
Heat rejected in cooling water	2700	26.9
Heat rejected in exhaust gases	2582	25.8
Heat lost due to moisture formed by the burning of hydrogen	228	2.2
Heat lost by incomplete combustion	205	2.0
Heat unaccounted for, including radiation	1774	17.7
Total heat consumed per i.hp.-hr.	10,034	100.0

The plant was put in readiness for the test by the manufacturer's representative, who installed the test flywheels and prony brakes and operated the plant during the test. The university furnished and installed the remainder of the test apparatus, including meters, pitot tubes, gas-analyzing apparatus for fuel and exhaust gases, and the gas calorimeter.

An unusual feature was the means provided to secure continuous determinations of the calorific value of the gas. Continuous samples were drawn from the main by a water aspirator which delivered water and gas to a

small tank where the desired pressure was maintained by regulating the water-outlet valve. The calorimeter was of the simple Junker type, with Centigrade thermometers, the wet meter reading to thousandths of a cubic foot, and the water-measuring receptacles graduated in cubic centimeters.

Four preliminary runs of approximately ten hours each at no load, one-fourth, one-half and three-fourths load, respectively, were made to insure satisfactory operation of the plant and test apparatus and to bring the producer up to the condition of every-day operation. Following these runs the final test was made at full rated load and without stops for a period of twenty-four hours. Observations were taken at fifteen-minute intervals during all the tests.

Remarks

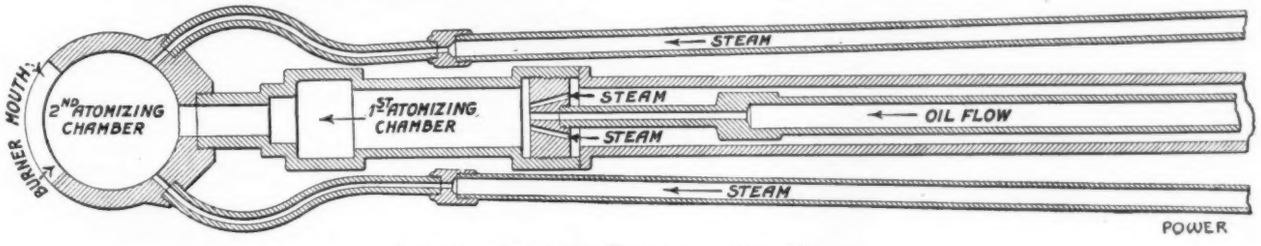
The gas volumes were calculated from the analyses of the coal and gases, because the four pitot tubes installed were so greatly affected by the engine pulsations that their indications were wholly unreliable.

The high mechanical efficiency is probably due, in part at least, to the fact that two of the four indicators used were steam-engine indicators.

It would seem that the manufacturer might arrange to utilize part of the heat lost in the exhaust gases by taking the air necessary for combustion from a preheater surrounding the exhaust gases. In this particular case the owner of the plant can doubtless utilize a sufficient amount of this heat to furnish the hot water necessary for shower baths and other purposes.

Champion Oil Burner

This oil burner is designed to atomize the fuel oil twice during its passage through the burner and also to control the size and shape of the flame. The illustration is a sectional view of the burner.



Section through Champion Oil Burner

As shown, there are two atomizing chambers. The steam comes into the first from above and below the oil-supply pipe, and the mixture then passes to the burner head. Just before it leaves this head it comes in contact with the two jets of live steam from the two side pipes which enter the burner head in the second atomizing chamber, where the mixture is again atomized as it goes to the mouth of the burner.

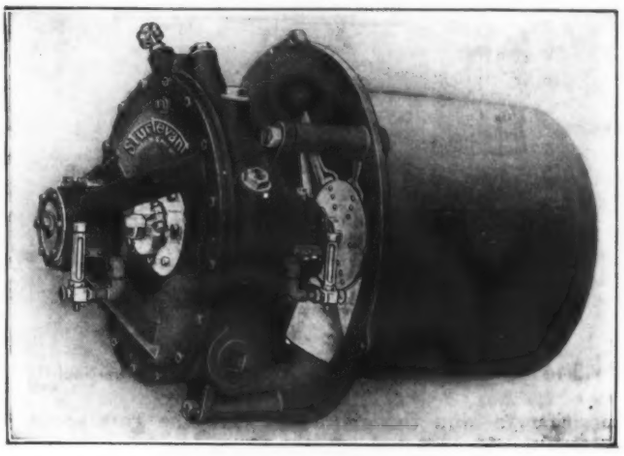
In addition to atomizing the oil the second time, the steam from the two side pipes gives the operator control of the blaze. By closing the valves on these two pipes the blaze will shoot straight back into the furnace, but by opening them the shape of the blaze is controlled. The burner works in connection with a pump and pressure tank, is made to fit any furnace, and is easily placed.

This burner is manufactured by the Champion Oil Burner Co., Kingman, Kan.

Sturtevant Turbo Undergrate Blower

A new design of undergrate blower for use where more furnace draft is needed is placed in the boiler brickwork.

In this set (see illustration), which is made by the B. F. Sturtevant Co., Hyde Park, Boston, Mass., the turbine is practically identical with the large standard turbines built by the company. The bearings are provided with oil-ring lubrication, and a floating, metallic stuffing-box prevents steam from getting into the bearings and enables a back pressure of 15 lb. to be carried.



Sturtevant Turbo Undergrate Blower

The new machine is controlled by from one to six nozzles, according to the amount of steam required. The fireman can shut off any number of nozzles to regulate the steam consumption at low loads.

Wrought Iron—Taken for the purpose of general calculations, the average weight of one cubic foot of wrought iron is 480 lb. per cu.ft., or 40 lb. per sq.ft. one inch thick.

Steel—The average weight of one cubic foot of steel is taken as 489.6 lb. per cu.ft., or 40.8 lb. per sq.ft. one inch thick.

More Gas than Oil—Pennsylvania's supply of gas will outlast the state's supply of oil, in the opinion of Roswell H. Johnson, professor of oil and gas production in the School of Mines in the University of Pittsburgh. Pennsylvania stands sixth among the states as a consumer of oil and second as a consumer of gas. Since 1903 the oil supply has been declining, Prof. Johnson declared, while the supply of gas has been increasing. If there were greater markets, he says, more gas could be produced, as the state has large reserves of gas lying in the deeper sands.

Governor-Stop Control and Belt Tightener

This device is designed for the purpose of allowing the governor stop to remain in position to prevent the shutting down of the engine in case of an overload and to remove the stop and allow the governor to fall to its lowest

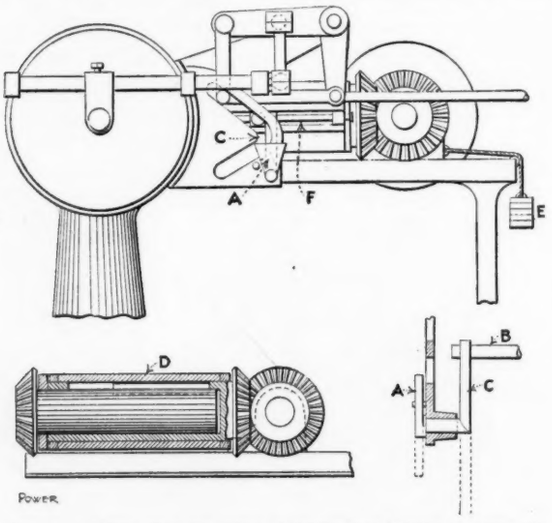


FIG. 1. DETAILS OF THE GOVERNOR-STOP CONTROL

position to stop the engine in case the governor belt breaks or runs off the pulley.

Referring to Fig. 1, *A* represents the governor stop in a position to reverse the governor with the engine stopped. The dotted lines show the governor stop in its lowest po-

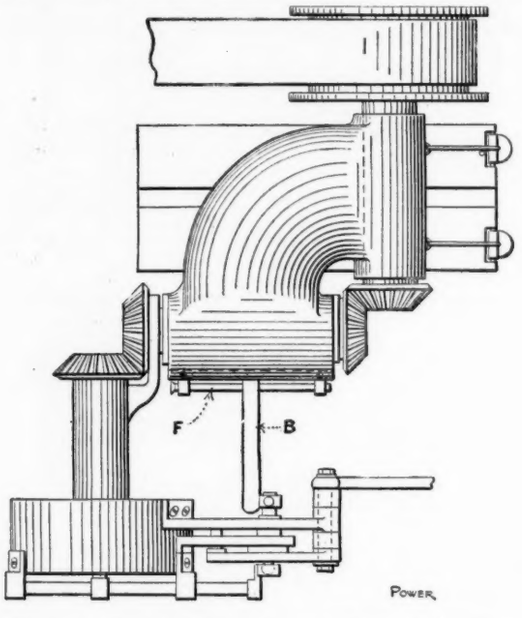


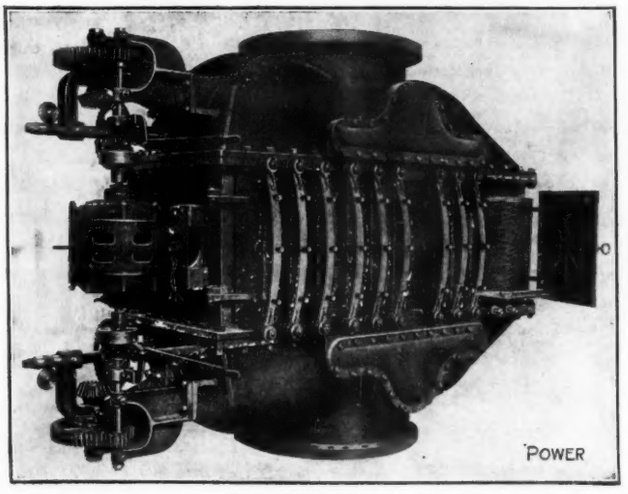
FIG. 2. PLAN VIEW OF THE STOP CONTROL

sition. The stop receives motion from the governor-stop controlling rod *B*. When the engine is running and the governor is performing its normal operation, the governor stop will rise in its "up position" with the governor-control pin *B* in contact with the arm *C* of the stop. If the engine should become suddenly overloaded the governor will drop to the governor stop and descend no farther, thus allowing the engine to continue running; in case the governor belt should break or slip off the pulley, the carriage *D* would be shifted on the bed by the weights *E*. This sliding movement of the carriage causes the controlling rod *A* to strike the arm *C* and to move the governor stop out of its elevated position, turning it to the position shown by the dotted lines. Consequently, when the governor drops, it moves to its lowest position and stops the engine. The weights also exert a pull on the governor belt, thus maintaining a proper tension. The stretching of the belt may alter the position of the stop control rod *A*, and this is compensated for by adjusting the screw rod *F* (Fig. 2) which passes through the pin *A*.

Motor-Operated Twin Strainer

Multiple strainers have performed such good service in connection with water-supply lines, condensers, etc., that they are now regarded as desirable in all uptodate installations.

The shifting of the valves on the small twin strainers by hand is simple, whereas on the larger units up to 48



MOTOR-OPERATED TWIN STRAINER

in., the time consumed in changing over from one side to the other is an item and involves considerable manual labor. To overcome these objections, the Elliott Co., Pittsburgh, Penn., has recently adopted a motor drive applicable to all its twin strainers of 20 in. and above.

An electric motor is mounted on one end of the strainer and drives trains of gears communicating with the two valve stems, friction clutches controlling each valve stem independently of the other, and also independently of the motor. Each stem has a device for indicating the position of each valve. The illustration shows one of the baskets partially removed for cleaning purposes.

After the baskets are cleaned and replaced and the doors closed, and it becomes necessary to open up the baskets on the other side of the strainer for cleaning, the motor is started, and at full speed one of the friction clutches is caused to engage the motor shaft, which moves the valve off its seat. This clutch is then released and the other clutch thrown into engagement with the other shaft, which moves the other valve from its seat. Then both friction clutches are thrown into engagement with the motor shaft and the valves are moved together to the opposite side of the strainer.

When the valves are about an inch from their seating

position, one clutch is thrown out of service and the full power of the motor is then employed in seating one valve. After it is seated, its clutch is released and the other clutch is thrown into service, which seats the second valve. The motor is then stopped, the doors opened and the baskets cleaned.

When it becomes necessary to shift the valves in the other direction, the rotation of the motor is reversed and the same operation is repeated.

On a 36-in. strainer the time required to start up the motors and shift the valves from one side to the other is 61 seconds, and to take off the doors and remove the baskets, clean and replace them, on this size strainer, requires less than ten minutes. This added to the time for shifting makes the total time needed to clean a 36-in. twin strainer less than eleven minutes, whereas with the hand-operated screws the time would be about three times as long. The time element in changing strainer baskets is important in order to prevent loss of vacuum and of water-supply, especially when the water strained contains large quantities of leaves and other foreign substances during high-water periods.

Equipment and Methods in Largest Refrigeration System--V

By Charles H. Bromley

SYNOPSIS—A novel gage records the height of brine in the tank, an ordinarily difficult practice due to precipitation of the calcium. A gage of the same general design records the height of water in the condensing water crib, and this together with the manometer tube connected in the suction main enables the operator to avoid low water due to plugged screens. Turbo-generators furnish energy for light and power for the plants, warehouses and Clinton Market. An exceptionally well trained crew operates the plant, maintains it, and rebuilds it as it wears out. The record system is most complete. The article concludes with a description of the lubricating system and ammonia condensers.

Novel Recording Brine Gage

The amount of brine in the suction tank is an indication of the tightness of the system, for if there is a serious leak it will not be long before the brine level will drop perceptibly. To register or record, by pressure by ordinary means, the height of brine in the tank is practically impossible if accuracy is desired, because in time the calcium settles out and, due to its weight, gives readings which are too great. To eliminate error due to calcium, a diaphragm chamber is used in connection with the recording gage, the outfit being shown in Fig. 21. As the

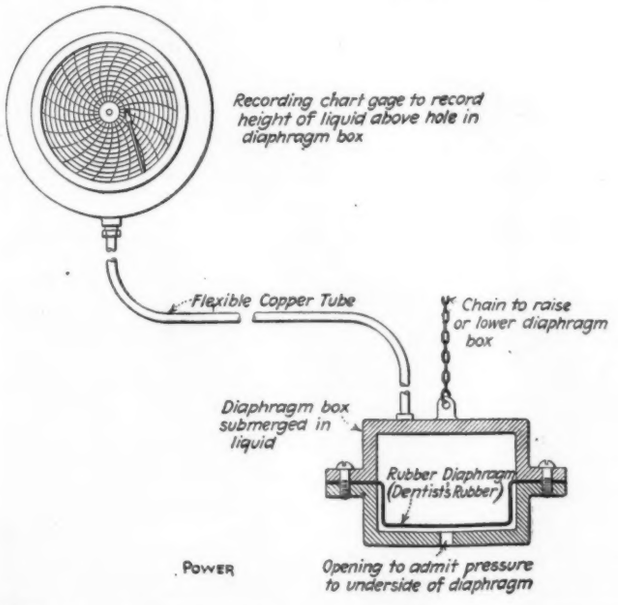

Recording chart gage to record height of liquid above hole in diaphragm box
Flexible Copper Tube
Chain to raise or lower diaphragm box
Diaphragm box submerged in liquid
Rubber Diaphragm (Dentist's Rubber)
Opening to admit pressure to underside of diaphragm
POWER

Fig. 21. Section of Type of Gage for Measuring Height of Brine and Condenser Cooling Water

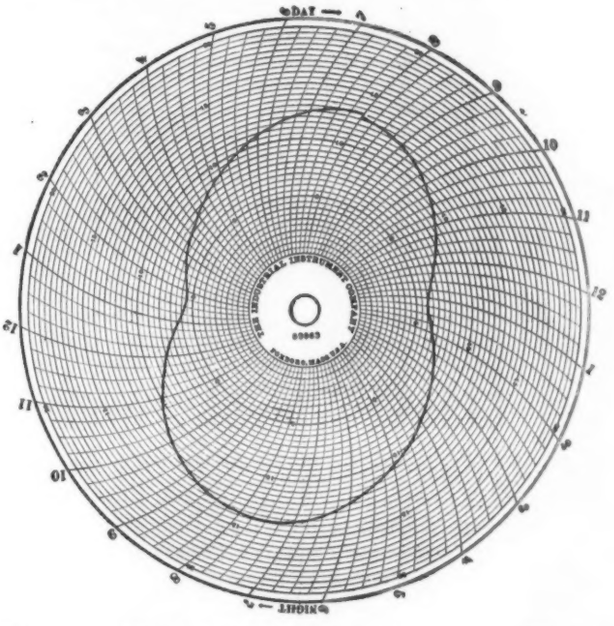


Fig. 22. Chart Showing Rise and Fall of Tide in Crib for Condenser Cooling Water

height of liquid above the hole in the bottom of the diaphragm box increases it pushes up the diaphragm, made of dentist's rubber, thus increasing the air pressure on the recording gage.

Similar Gage Used to Measure Tide

Water for the ammonia and steam condensers is taken from a crib in which the height is governed by the tide. The height in the crib was formerly kept track of by a tide table written on a blackboard in the engine room, but now a record of the tide and the height of water in the crib is recorded by the same kind of outfit as used for measuring the brine. A chart from the tide gage showing the action of the tide on June 18 of this year

is shown in Fig. 22. Notice that the maximum high tides for the day differ by a foot and the low tides by 6 in. There are other interesting features if one has the time to study them. Below the gage that records the height of water in the crib is the manometer tube of a venturi meter, Fig. 23. These two gages tell a man all he needs to know about the water condition in the

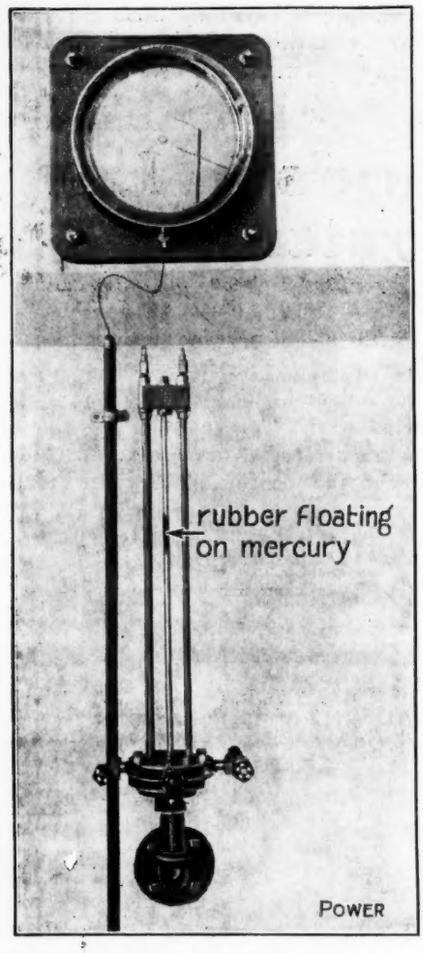


FIG. 23. MANOMETER TUBE OF VENTURI METER FOR COOLING WATER SUCTION LINE PLACED BELOW DIAL GAGE THAT RECORDS HEIGHT OF WATER IN COOLING WATER CRIB

crib and offer him no excuse for losing the water because of dirty screens, as a plugged screen is immediately indicated. A piece of hard black rubber was put in the tube and the instrument calibrated with the rubber floating on the mercury. This makes it easy to quickly get readings.

ELECTRIC-GENERATING EQUIPMENT

The two main generating sets are turbine driven and are each of 500-kw. capacity, of 450 volts and 3600 r.p.m. Both turbines operate under nearly 29 in. vacuum in winter, 146 lb. pressure and 125 deg. superheat; total temperature, 486 deg. F. Although the superheat at the boilers is 125 deg. F., there is a 15-deg. drop between the superheaters and the turbines. Indicating and recording thermometers are provided in the steam inlet and exhaust pipes.

Two 10-kw. induction motor-driven and one 10-kw. engine-driven, direct-current generators light the station. Light and power as well as refrigeration are furnished to some of the warehouses, and Clinton Market gets its light, power and refrigeration from this station. The switchboard is quite completely fitted, having, besides other instruments, integrating wattmeters, alternating-current load-averaging meters, power-factor meter, graphic voltmeter, syncroscope and a frequency meter. The turbine at the right, Fig. 25, has the distinction of having made a nonstop run for 18 months. The turbines average about 18 lb. steam per kilowatt-hour, and the cost of current is approximately ¾ cent per kilowatt-hour at the board.

A central surface condensing system is used. Many of the tubes in these condensers have been in service for twelve years and are still in good condition. The tubes are made of a composition consisting of 88 per cent. copper, 10 per cent. tin and 2 per cent. lead, a most unusual composition, for there is seldom more than 1 or 2 per cent. tin and nearly always considerable zinc in condenser tubes, except in some of those brought out recently, namely, aluminum bronze, cupro-nickel and Monel metal. The water in Boston Harbor is quite pure compared to that of the East, Hackensack, Chicago, and other rivers on which there are large condensing plants.

The feed water and the circulating water are measured with venturi meters.

LABOR

All labor is departmentized, there being a separate crew for each division of work; the engineers work eight

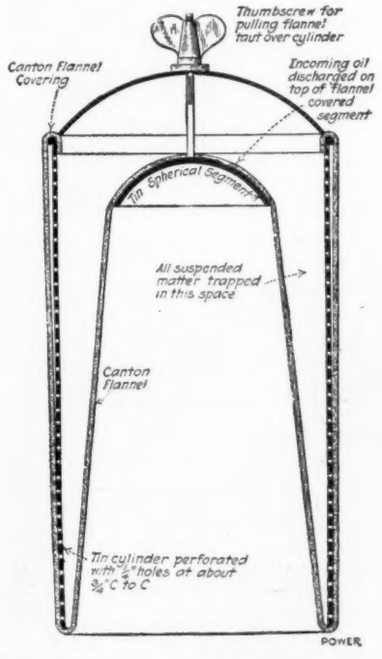

Thumbscrew for pulling flannel taut over cylinder
Canton Flannel Covering
Incoming oil discharged on top of flannel covered segment
Tin Spherical Segment
All suspended matter trapped in this space
Canton Flannel
Tin cylinder perforated with ½" holes at about ¾" C to C
POWER

FIG. 24. ONE OF THE PERFORATED FLANNEL-COVERED CYLINDERS FOR THE OIL FILTERS

hours and all other employees nine hours a day. The engineers are not allowed to make any mechanical adjustments or repairs except in emergencies; the machinists do all such work. The same is true of all pipe fitting, pipe covering, electrical work, etc.; a separate crew looks after the street system. The company pays for telephones in the homes of all foremen of the crews.

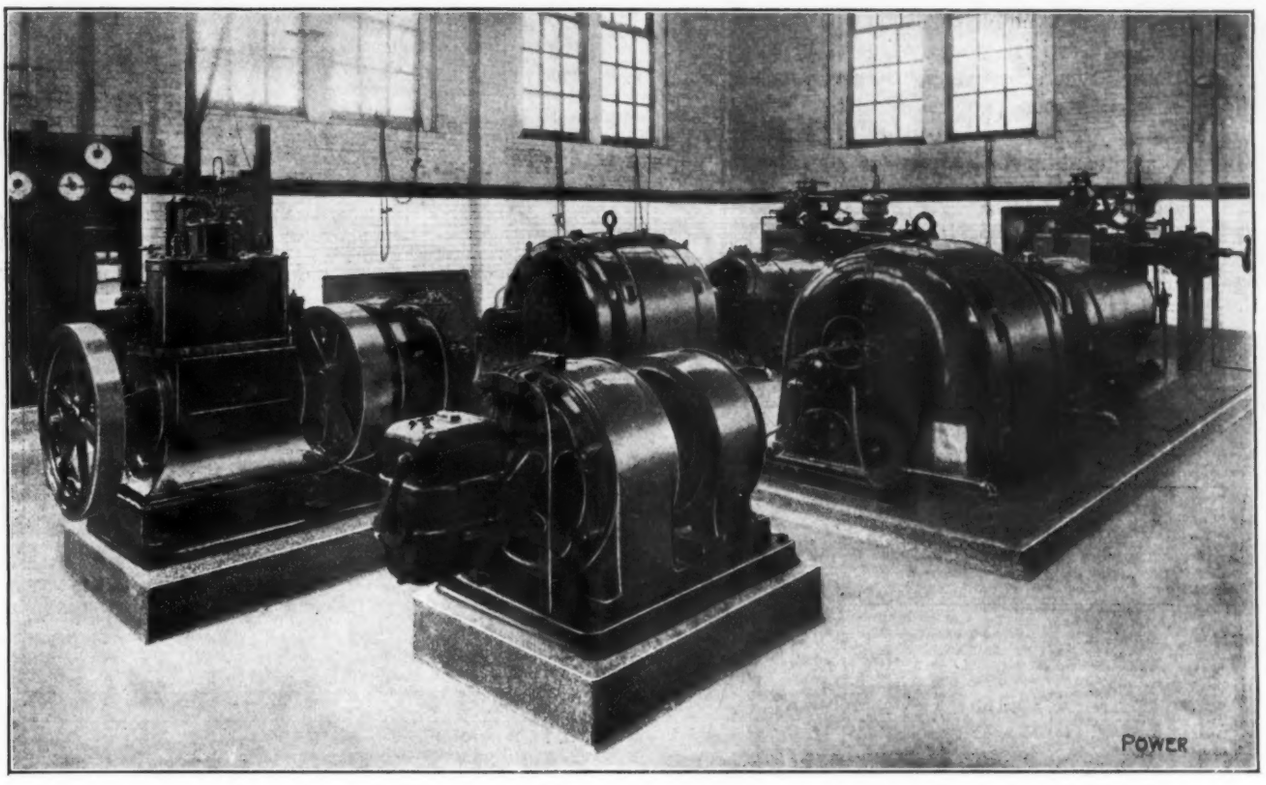


FIG. 25. TURBO-GENERATOR PLANT AT SARGENT'S WHARF
The turbine on the right made a nonstop run of 18 months.

As all except heavy-machine and repair work is done by the different gangs, it enables the company to maintain workmen who in time become trained in team work and thoroughly familiar with the plant. These men do excellent work, too, as is evidenced by even a casual look around the engine room. The lagging, for example, is exceptionally good. Much of the lagging that one finds in plants is made of thin Russian iron, which, after it has been taken off and put on a few times, would exhaust the patience of anyone to get on again. At the Sargent's Wharf plant the iron for the lagging is in heavy sheets and the reinforcing strips used are likewise heavy.

RECORDS

Seven different record forms, including a "summary," are made out daily in the engine room. In addition, there are turned into the chief's office more than a score of charts from recording instruments for various purposes. All record sheets are of uniform size. Reports,

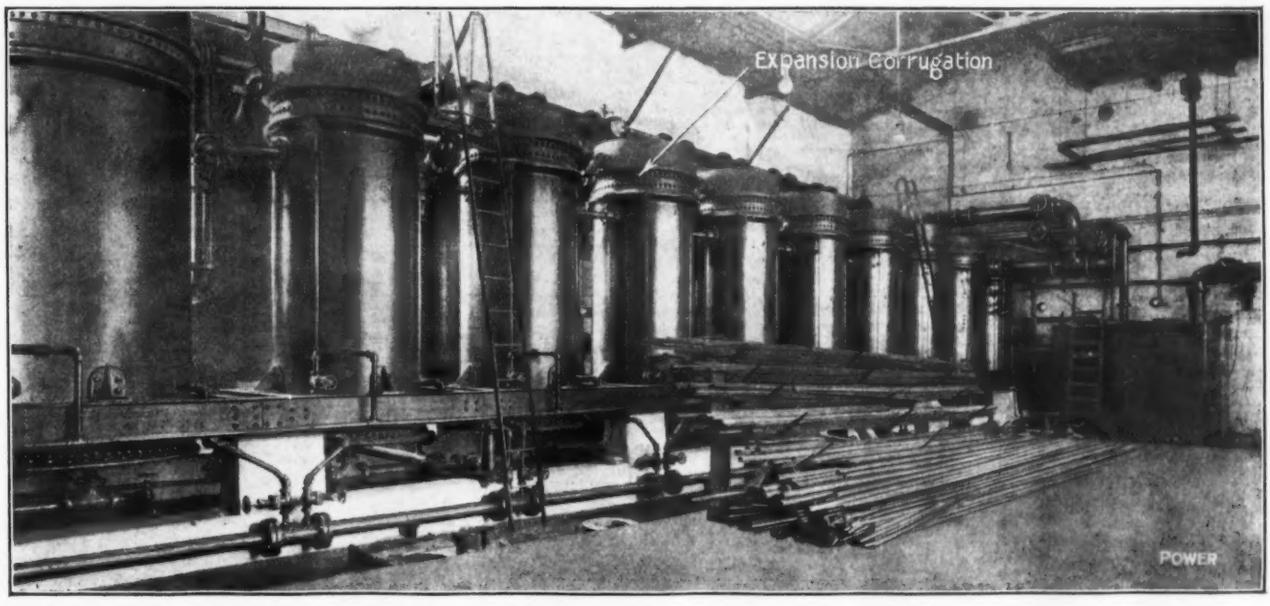
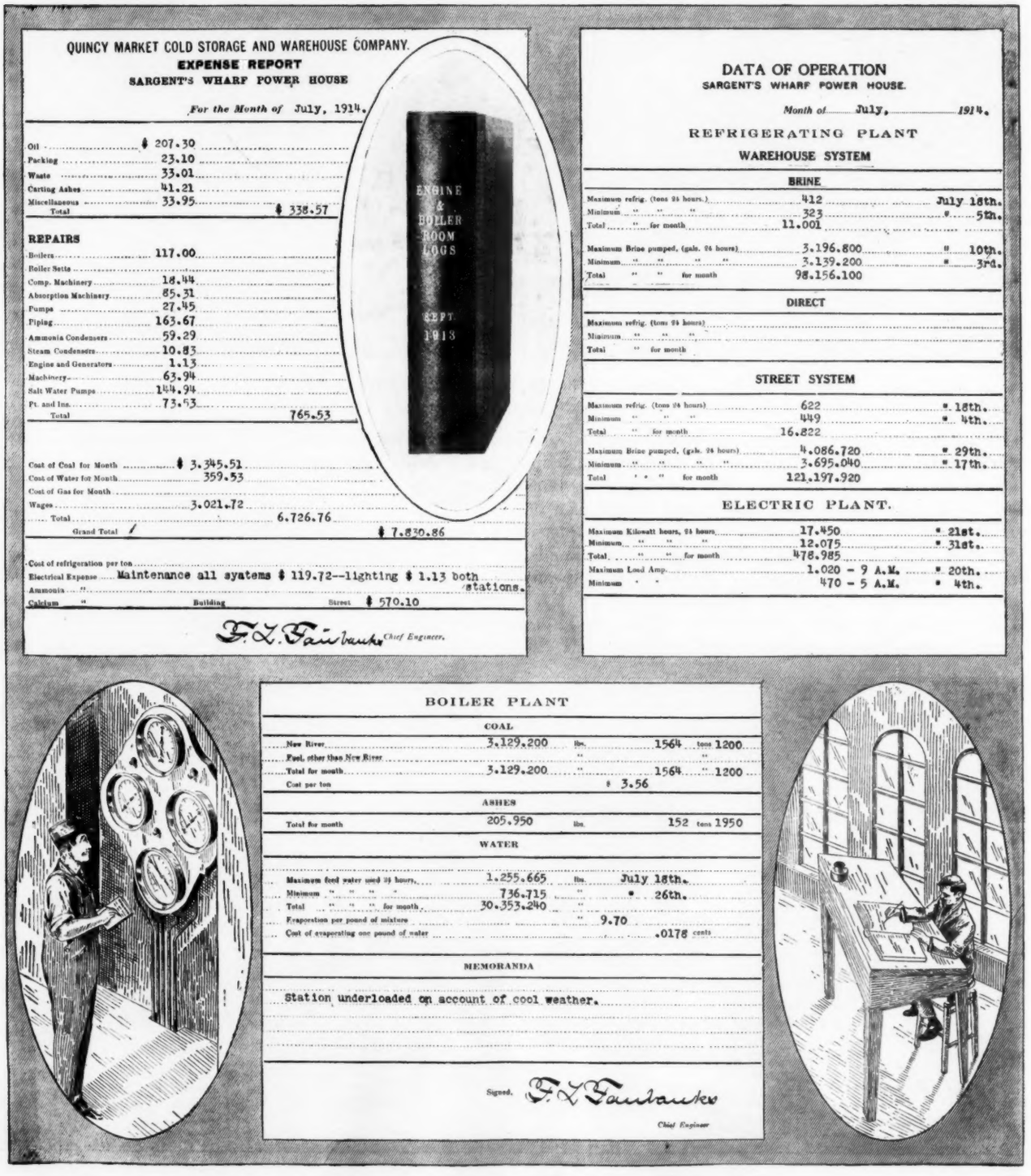


FIG. 26. SHELL-TYPE AMMONIA CONDENSERS
The condensers were built for 300 lb. pressure. Note the expansion corrugation that each has to allow for expansion and contraction.

Fig. 27, giving maximum items and costs per units of refrigeration, electricity, water evaporated, etc., are forwarded to the general manager. Report sheets from the engine and boiler rooms are bound in regular book form, size 9½x8 in., shown, and filed in the chief's office; a single volume contains one month's daily reports.

Lubricating Main Bearings

A bearing may be adjusted for running clearance—i.e., clearance enough to allow for smooth running with the brasses and journal at normal temperatures—or it may be given enough clearance so that should it become hot from any cause the expansion of the brasses and journal will not be sufficient to cause the bearing to "freeze" or grip so tightly as to make it unfit for use without much scraping. As pounding frequently accompanies expansion-clearance adjustments, it is the usual practice to adjust for running clearance. No trouble is had so long as the lubricating oil is of proper quality and is supplied in sufficient quantities and no foreign matter gets into the bearing, but sometimes the system oil "wears out" and trouble begins.



QUINCY MARKET COLD STORAGE AND WAREHOUSE COMPANY.
EXPENSE REPORT
SARGENT'S WHARF POWER HOUSE
For the Month of July, 1914.

Oil	$ 207.30	
Packing	23.10	
Waste	33.01	
Carting Ashes	41.21	
Miscellaneous	33.95	
Total		$ 338.57
REPAIRS		
Boilers	117.00	
Boiler Setts		
Comp. Machinery	18.44	
Absorption Machinery	85.31	
Pumps	27.45	
Piping	163.67	
Ammonia Condensers	59.29	
Steam Condensers	10.83	
Engine and Generators	1.13	
Machinery	63.94	
Salt Water Pumps	144.94	
Pt. and Ins.	73.53	
Total		765.53
Cost of Coal for Month	$ 3.345.51	
Cost of Water for Month	359.53	
Cost of Gas for Month		
Wages	3.021.72	
Total		6.726.76
Grand Total		$ 7.830.86

Cost of refrigeration per ton
Electrical Expense Maintenance all syatems $ 119.72—lighting $ 1.13 both stations.
Ammonia "
Calcium " Building Street $ 570.10

F. L. Fairbanks Chief Engineer.

ENGINE & BOILER ROOM LOGS
SEPT. 1913

DATA OF OPERATION
SARGENT'S WHARF POWER HOUSE.
Month of July, 1914.

REFRIGERATING PLANT
WAREHOUSE SYSTEM

BRINE		
Maximum refrig. (tons 24 hours.)	412	July 18th.
Minimum " " "	323	" 5th.
Total " for month	11.001	
Maximum Brine pumped, (gals. 24 hours)	3.196.800	" 10th.
Minimum " " " "	3.139.200	" 3rd.
Total " " for month	98.156.100	

DIRECT		
Maximum refrig. (tons 24 hours)		
Minimum " " "		
Total " for month		

STREET SYSTEM		
Maximum refrig. (tons 24 hours)	622	" 18th.
Minimum " " "	449	" 4th.
Total " for month	16.822	
Maximum Brine pumped, (gals. 24 hours)	4.086.720	" 29th.
Minimum " " " "	3.695.040	" 17th.
Total " " for month	121.197.920	

ELECTRIC PLANT.

Maximum Kilowatt hours, 24 hours	17.450	" 21st.
Minimum " " "	12.075	" 31st.
Total " for month	478.985	
Maximum Load Amp.	1.020 – 9 A.M.	" 20th.
Minimum " "	470 – 5 A.M.	" 4th.

BOILER PLANT

COAL

New River	3.129.200	lbs.	1564	tons 1200
Fuel, other than New River		"		"
Total for month	3.129.200	"	1564	" 1200
Cost per ton			$ 3.56	

ASHES

Total for month	205.950	lbs.	152	tons 1950

WATER

Maximum feed water used 24 hours	1.255.665	lbs.	July 18th.
Minimum " " "	736.715	"	" 26th.
Total " " " for month	30.353.240	"	
Evaporation per pound of mixture		"	9.70
Cost of evaporating one pound of water			.0178 cents

MEMORANDA

Station underloaded on account of cool weather.

Signed. F. L. Fairbanks
Chief Engineer

Fig. 27. Some of the Report Forms Used at Sargent's Wharf

All important reports are made on sheets of uniform size and monthly reports are bound as shown by the log book at the top of this illustration.

In many plants where oil is put through filters, returned to the system and used over and over again, serious troubles sometimes arise due to hot bearings. No good reason is evident; the oil is clean and supplied in the usual or even greater quantities, yet nearly all the bearings are hot at the same time. Trouble of this nature frequently happens on a hot summer's day. The reason usually lies in the fact that the system oil has so weakened in viscosity and specific gravity that when an extra warm day comes, with its increase in load, if the plant supplies refrigeration it cannot furnish sufficient lubrication; therefore all bearings with small running clearances and those supporting heavy journals which squeeze out the thin oil overheat.

System Oils Tested Daily

To prevent this trouble in the Quincy Market Co.'s plants the night engineer tests a sample of each system oil each day for the viscosity and specific gravity, the report going to the chief engineer, who will direct that fresh oil be added to increase these properties when the reports show this to be necessary.

Oil Filters

The filters through which the oil finally passes on its way to the engines were made in the plant. Briefly, their construction is this: A tank of oblong section has six canton flannel-covered perforated cylinders set into it, all the cylinders being supported by a sheet-tin partition. Fig. 24 shows how the cylinder is covered with flannel. The oil flows to the cylinder through 5/8-in. brass pipe, a swinging elbow and a nipple instead of a valve being used to stop the oil flow to each of the six cylinders in a filter.

Ammonia Condensers

The present ammonia condensers are of the shell type. Formerly open-coil condensers were used and located in the place now occupied by those of the shell type shown in Fig. 26. To insure a steady flow of water over them, the cooling water was pumped into a large tank at the right of the room and elevated 20 ft. above the condensers, the water gravitating to the latter. When the present condensers were installed this tank was not needed, and as the discharge head was decreased 20 ft., it helped to increase the pump's capacity.

Another advantage following the introduction of the shell-type condenser was that no water was splashed over the floor, on the I-beams, etc. This is more favorable than one may at first believe, but a look at the balcony of the Richmond St. plant, where the structural work was very seriously corroded in only seven years, convinces one that the shell-type condenser is best for the conditions in these two plants.

The condensers are 4 ft. in diameter and contain 367

PRINCIPAL EQUIPMENT OF SARGENT'S WHARF STATION, QUINCY MARKET, COLD STORAGE AND WAREHOUSE CO.

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
5	Boilers	Watertube "Stirling"	350 hp.	Steam generation	Stoker fired, 140 lb. pres., 125 deg. F. superheat	Babcock & Wilcox Co.
5	Boilers	Scotch	300 hp.	Steam generation	Hand fired, 140 lb. pres., 125 deg. F. superheat	Atlantic Works, Boston
5	Stokers	Underfeed		Boiler furnaces	Bituminous coal—New River, straight	American Engineering Co.
1	Combustion cont'l system	Balanced draft	All ten boilers	Combustion control	With forced-induced draft	Blaisdell-Canady Co.
10	Superheaters	Connected		Superheated steam	140 lb. pres., 125 deg. F. superheat	Foster Engineering Co.
	Economizers	Tube		Feedwater heating	Intake 225 deg. F.; outlet 275 deg. F.	Green Fuel Economizer Co.
10	Feedwater regulators		2-in.	Feedwater flow regulation	140 lb. pressure	Boston Steam Specialty Co.
2	Injectors	Double tube-"Buffalo"	2½-in.	Feedwater system-emergency	140 lb. pressure, through economizer	Sherwood Mfg. Co.
1	Draft system	Forced-induced		Boiler purposes	Fan system, 4 in. in ashpits, 0.2 in. over fires	B. F. Sturtevant Co.
1	Feedwater heater	Closed		Primary heating	Inlet 60 deg. F.; outlet 100 deg. F.	Wainwright
2	Draft gages	"Steinbardt"		Draft over fire—recording	0.2 to 0.4 in. connected to "Gascomposmeter"	Uheling Instrument Co.
1	Draft gage	Indicating		Draft over fire—indicating	0.2 to 0.4 in.	Uheling Instrument Co.
1	CO_2 recorder	"Gascomposmeter"		CO_2—recording	Gas taken from main uptake	Uheling Instrument Co.
2	Turbines	Horizontal	500 kw.	Electric generator drive	140 lb. pres., 125 deg. F. superheat, 1120 r.p.m., 28 in. vac.	Westinghouse Machine Co.
1	Turbine	Horizontal	135 hp.	Pump drive	140 lb. pres., 1200 r.p.m. condensing	Terry Steam Turbine Co.
1	Ammonia compressor	Angle-compound	1000 tons	Refrigeration		Providence Engineering Works
1	Ammonia compressor	Angle-compound	800 tons	Refrigeration		Pennsylvania Iron Works
1	Ammonia compressor	Angle-compound	400 tons	Refrigeration		Pennsylvania Iron Works
1	Ammonia compressor	Angle-single		Pumping ammonia from system	General pumping	Frick Engineering Co
2	Brine pumps	Cross-compo'd, pot type	Each 10,000,000 gal. per day	Brine circulation	Street and warehouse systems	Snow Steam Pump Works
1	Brine pump	Turbine	8-in.	Emergency brine circulation	Induction motor driven	Worthington Steam Pump Co.
13	Ammonia condensers	Shell type		Ammonia gas condensation	Salt-water cooled, series connected	The Bigelow Co.
2	Pumps	Volute	10-in.	Salt water for all cooling	Induction motor driven, 1120 r.p.m.	Wheeler Condenser & Engineering Co.
1	Pump	Volute	14-in.	Salt water for all cooling	Turbine driven, 1200 r.p.m.	Wheeler Condenser & Engineering Co.
1	Pump	Triplex	12x14-in.	Salt water for all cooling	Engine driven	Goulds Mfg. Co.
1	Pump	Duplex-compound, plunger	6½, 10x6-in.	Feedwater system	Automatic control	Snow Steam Pump Works
1	Pump	Triplex	6x10-in.	Feedwater system	Automatic control, motor driven, continuously operated	Goulds Mfg. Co.
2	Pumps	Reciprocating	9, 22x12-in.	Air from surface condenser	28-in. vac.; steam driven	Wheeler Condenser & Engineering Co.
2	Condensers	Surface		Central condensing system	Use water from ammonia condensers	Wheeler Condenser & Engineering Co.
2	Generators	Turbo; alternating current	500 kw.	Current for station use	3600 r.p.m., 440 volts, 2-phase, 60 cycle	Westinghouse Electric & Mfg. Co.
2	Generators	Direct current	10 kw.	Station lighting	1125 r.p.m., 125 volts, 80 amp., motor driven	Westinghouse Electric & Mfg. Co.
1	Generator	Direct current	10 kw.	Station lighting	1125 r.p.m., 125 volts, 80 amp., engine driven	Westinghouse Electric & Mfg. Co.
1	Motor	Induction	15 hp.	D.c. generator	1120 r.p.m., 440 volts, 2-phase, 60 cycle	Westinghouse Electric & Mfg. Co.
1	Motor	Induction	200 hp.	Turbine brine pump	440 volts, 2-phase, 60 cycle	Westinghouse Electric & Mfg. Co.
1	Motor	Induction	20 hp.	Triplex feed pumps	1120 r.p.m., 440 volts, 2-phase, 60 cycle	Westinghouse Electric & Mfg. Co.
2	Motors	Induction	100 hp.	Salt water pump	1120 r.p.m., 440 volts, 2-phase, 60 cycle	Westinghouse Electric & Mfg. Co.
1	Switchboard	Gray marble	Four-panel	Main electrical control	Alternating and direct current	Quincy Market C. S. & W. Co.
5	Engine stops			Compressors and brine pumps		Locke Regulator Co.
1	Engine	Single acting	20 hp.	D.c. generator drive	Station lighting	Westinghouse Machine Co.
1	Air compressor	Single stage	6x6-in.	General service	Steam driven	Ingersoll-Sargent Co.
1	Oil filter	Centrifugal		Waste oil		Oil & Waste Saving Machinery Co.
1	Waste washer	Centrifugal				Oil & Waste Saving Machinery Co.

Note: The big steel forgings for the 1000-ton compressor were made by the Bethlehem Steel Co.; the steel castings, by the Chester Steel Casting Co.; the very large castings for the bed plate and A-frames by the Farrell Foundry and Machine Co.; the bronze castings by the Philadelphia Phosphor Bronze Smelting Co.; the steam and ammonia cylinders by the J. C. Colvin Co. and the condensers and coolers by The Bigelow Co., makers of the Hornsby-Bigelow boiler. All piping and valves are of the Quincy Market Cold Storage and Warehouse Co.'s make.

one and one-half inch Shelby cold-drawn steel tubes, each 8 ft. long; the condensers were built for 300-lb. pressure.

Notice the expansion corrugation in the condenser shell. When the Quincy Market Co. first drew up its specifications, this expansion corrugation was made of heavier metal than the rest of the shell and riveted to it, but experience shows that it is cheaper and better to make the whole shell of the thickness of the corrugation.

An unmistakable error appeared in article III, p. 883. The word "more" in the next-to-the-last line should be "less."

Electromagnets for Alternating-Current Circuits

By Norman G. Meade

SYNOPSIS—Electromagnets in general and sample calculations for the design of a pair of small magnets to operate on a 25-cycle circuit.

Alternating-current electromagnets differ from those used on direct-current circuits, and the calculations for the windings are essentially the same as for the primary winding of a static transformer. The cores are laminated and built up from soft iron or steel punchings, as in Fig. 1, which gives front and side views of a pair of tractive magnets for general use such as actuating mechanisms, lifting purposes, etc.

To secure economical design the electromagnet should conform to established proportions. It is essential that the magnetic circuit be complete and, where space will not permit the use of two coils, the construction shown in Fig. 2 may be used, the one coil serving to excite the consequent pole.

For long-range magnets—that is, where the pull exceeds an inch or more in length—the plunger style of construction, shown in Fig. 3, should be used. On single-

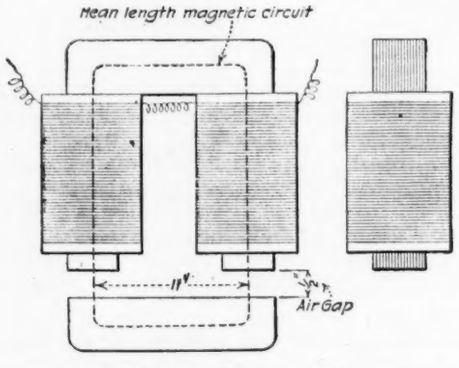


Fig. 1. Pair of Tractive Magnets

phase circuits, or when connected to one phase of a polyphase circuit, plunger magnets will make considerable noise, owing to the oscillations of the plunger. This can be relieved by placing a small compression spring between the plunger and the stop, as shown.

For alarm bells operating from an alternating supply circuit, the polarized electromagnet, shown in Fig. 4, is used. It has the distinctive advantage over direct-current signaling magnets in that no make-and-break contacts are necessary. The coils are wound in a manner similar to the direct-current magnets, but the armature is pivoted at the center and is free to move in both directions. A permanent magnet is attached to the electromagnet yoke; having the form of an elongated U, the lower end being just beneath the armature. When there is no current passing through the coils the cores will correspond in polarity to the permanent magnets as well as the armature, as indicated. When an alternating current flows through the coils, it will tend to strengthen one core and weaken the other at every alternation. The armature will then be drawn up to the strongest core,

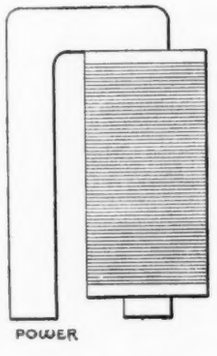


Fig. 2. Single-Coil Electromagnet

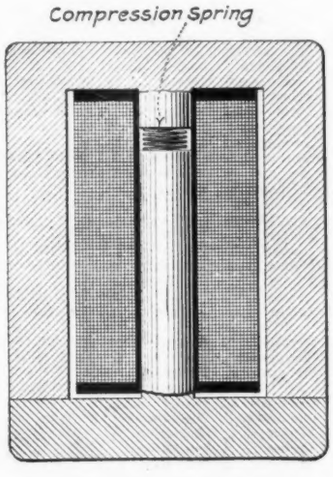


Fig. 3. Plunger Type

causing it to give the striker two vibrations during each cycle.

When the magnet coils are wound on metal spools, the latter should be split from end to end, as in Fig. 5, to prevent excessive loss due to eddy currents. Large coils are generally wound on forms and held in position on the cores by small brackets.

Magnet Calculations

The first essential in the design of an electromagnet is to determine the pull. Assume that it is desired to construct a pair of magnets, as in Fig. 1, which must have a combined pull of 50 lb. through a ½-in. air gap. The pull in the air gap decreases as the square of the distance, so that the magnets will have to be designed for a combined pull of 200 lb. for a total of one inch or ½ in. on each side. Assume a 25-cycle circuit and a core density of 30,000 lines of force to the square inch. The formulas for determining pull and the transpositions for determining the other factors are as follows:

$$P = \frac{B^2 \times A}{72{,}134{,}000}$$

$$A = \frac{72{,}134{,}000 \times P}{B^2}$$

$$B = \sqrt{\frac{P \times 72{,}134{,}000}{A}}$$

where,

P = Pull in pounds;
B = Magnetic density per square inch;
A = Area of core in square inches.

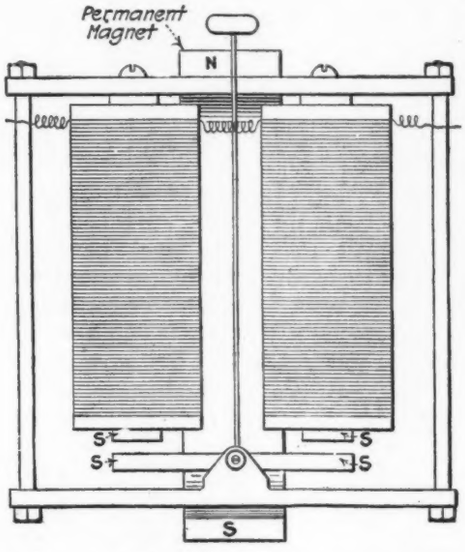


FIG. 4. POLARIZED ELECTROMAGNET

The pull is divided between the two magnets and therefore will be 100 lb. in each.

The area of the core will be:

$$A = \frac{72{,}134{,}000 \times 100}{30{,}000^2} = 8 \; sq.in. \; (approximately)$$

To allow for some losses, it will be best to make the core 9 sq.in., or 3 in. square.

The number of turns required will depend on the magnetic flux N which threads through the turns, the maximum value being expressed as follows:

$$N = B_{max} \times A$$

where B_{max} is the maximum value which the magnetic

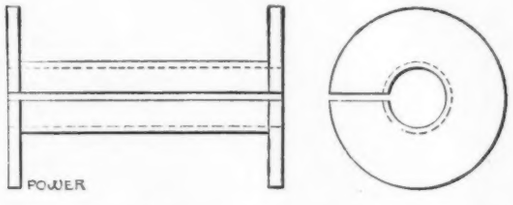


FIG. 5. SPLIT SPOOL TO PREVENT EDDY CURRENTS

density reaches during a cycle, and A is the cross-sectional area of the iron, in this case 9 sq.in. Hence,

$$N = 30{,}000 \times 9 = 270{,}000 \; lines.$$

Taking the induced electromotive force as equal and opposite to the line voltage,

$$E = \frac{4.44 \times N \times T \times n}{10^8}$$

where

N = Maximum value of the magnetic flux through the core;
T = Number of turns in the coil;
n = Frequency in cycles per second;
E = Impressed e.m.f.

Applying to the present example,

$$440 = \frac{4.44 \times 270{,}000 \times T \times 25}{10^8}$$

whence,

$$T = \frac{440 \times 10^8}{4.44 \times 270{,}000 \times 25} = 1468$$

Assume the core to be 9 in. long and the width of half the keeper and half the armature to equal 3 in. Also

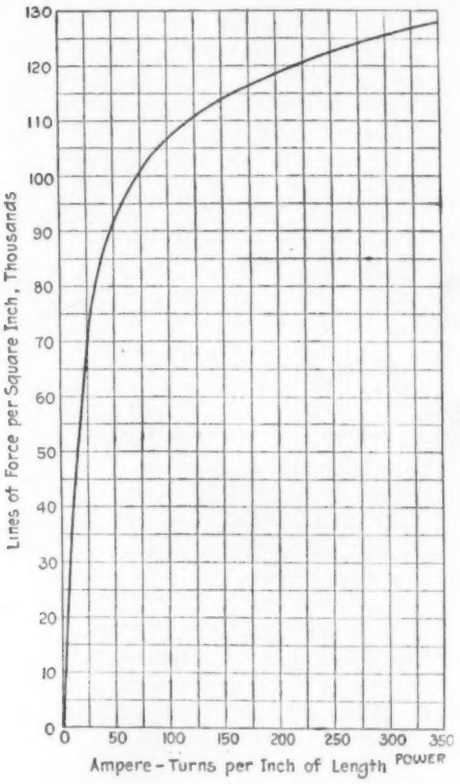


FIG. 6. AMPERE-TURNS VS. LINES OF FORCE

let the distance from center to center of the cores be 11 in. Then the length of one-half the magnetic circuit, or the length per pole = 9 + 3 + 5½ + 5½ = 23 in.

From a permeability curve the permeability of soft iron at a density of 30,000 lines per square inch is found to be 1100 and that of air is always taken as one; therefore, it will require 1100 times as many ampere-turns per inch of length of the magnetic circuit for the air gap. From Fig. 6 it will be found that approximately 5.5 turns per inch of length of the magnetic circuit are required. Then the turns per coil for the iron will be 23 × 5.5 = 126½, and for each air gap of ½ in., 5.5 × 1100 × 0.5 = 3025, and 3025 + 126 = 3151 ampere-turns per spool.

As there are 1468 turns per spool, the current will be approximately two amperes. Allowing 2000 circ.mils per ampere, it will be found from a wire table that No. 14 B. & S. gage corresponds the nearest to the required size. The table shows that No. 14 wire has 13 turns to the inch;

and, allowing 8½ in. as the length of the spool, the result is 13 × 8.5 or approximately 110.5 turns. Then 1468 ÷ 110.5 = 13+, the number of layers.

SINGLE COTTON-COVERED MAGNET WIRE DATA

B. & S. Gage	Turns per Inch	Layers per Inch
4	4.5	4.78
5	5.09	5.82
6	5.66	6.41
7	6.02	7.3
8	7.05	8
9	7.66	8.42
10	8.54	9.6
11	9.7	11
12	11.2	12.8
13	12	14
14	13	15.4
15	15.37	17.9
16	16.74	19.4
17	17.74	21.33
18	19.5	23
19	22.77	24.9
20	25.7	29.7
21	28.3	32.5
22	31	36
23	34.4	40.36
24	36.9	44.6
25	38	47
26	42	50.5
27	48	55.5
28	53.28	61.1
29	59	68
30	63.26	76.8

From the table it will also be found that there are 15.4 layers to the inch for No. 14 wire, so it will be necessary to allow 1½ in. for the depth of the winding, including the insulation between layers.

consists simply of a grooved brass wheel free to revolve on a pin supported by a forged-iron holder. By moving the lathe rest backward and forward the wire can be wound evenly and quickly. It should be wound under tension, which may be provided as shown in Fig. 10.

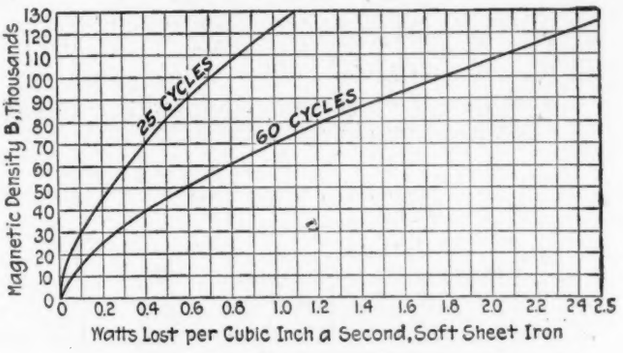


FIG. 7. HYSTERESIS CURVES

Practically all wire reels have a groove on one side which will receive a wire to which a weight is attached, as shown. The tension can be made as great or as little as desired by varying the weight. If there is no groove in the reel, a flat band of sheet iron or steel can be substituted.

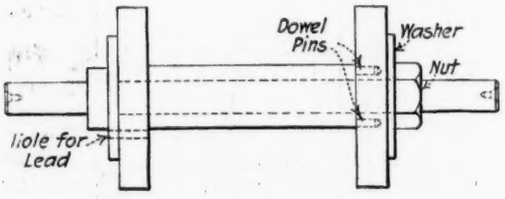


FIG. 8. FORM FOR WINDING COILS

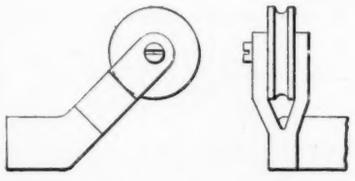


FIG. 9. GUIDE FOR WIRE

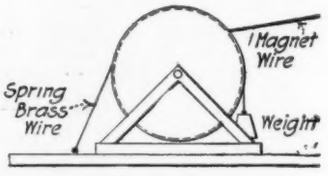


FIG. 10. METHOD OF PROVIDING PROPER TENSION

As the spool is square in cross-section, this will give each side a width of 3 in. or a perimeter of 12 in., and the mean perimeter of the coil is 18 in.

$$1468 \times 18 \div 12 = 2202 \text{ ft.}$$

is the length of wire per coil. The resistance of No. 14 wire is approximately 2.5 ohms per 1000 ft.; hence, there is approximately 12 ohms resistance for the two coils connected in series. Then the I^2R loss is $4 \times 12 = 48$ watts. The total core volume is $23 \times 2 \times 9 = 414$ cu.in. From the hysteresis curves, Fig. 7, it will be seen that for 25 cycles the loss per cubic inch is 0.1 watt, so that the hysteresis loss will be 41.4, and the eddy current loss may be estimated as 10 watts. Then the total loss in watts will be $48 + 41.4 + 10 = 99.4$ watts. The outside surface of the coils is $4 \times 6 \times 8.5 = 200$ sq.in. per coil. As at least one square inch of coil surface must be allowed for each watt lost, it will be seen that the figures are well within the safe limit.

For winding spool magnets, small hand-driven machines can be purchased at low cost, but a lathe is more satisfactory. Fig. 8 shows a simple form for winding coils which have no spools. It consists of a wooden spindle and end turned from one piece and mounted on a steel arbor. It is secured by a flange attached to the arbor with a pin or setscrew. One end of the spool is removable and is held in place by a nut and dowel pins.

A guide for the wire is shown in Fig. 9, which is intended to be clamped in the tool post of the lathe. It

To secure the last turn of wire on the coil in position, a piece of webbing in the form of a loop is laid under the last five or six convolutions and the wire end is passed through it, after which it is drawn up tight. The coil is then slipped off the spool or form and given a wrapping of tape or webbing, after which it should be given a thorough coat of insulating paint. It is generally preferable to solder a piece of flexible conductor to the wire ends inside the coil.

Nipples—A nipple is a fitting made from tubular goods, and usually threaded on both ends. It is under 12 in. in length. Pipe over that length is referred to as cut pipe.

A close nipple has no shoulder and is about twice the length of a standard pipe thread.

A shoulder nipple has any length. It derives its name from the shoulder of pipe left between the two threads. A shoulder nipple is intermediate in length between a close and a short nipple.

A short nipple is slightly longer than the lengths of the two threads, being a trifle longer than a close nipple. Some unthreaded shoulder exists between the two threads.

A space nipple contains a shoulder between the two threads, and may be of any length allowing a shoulder.

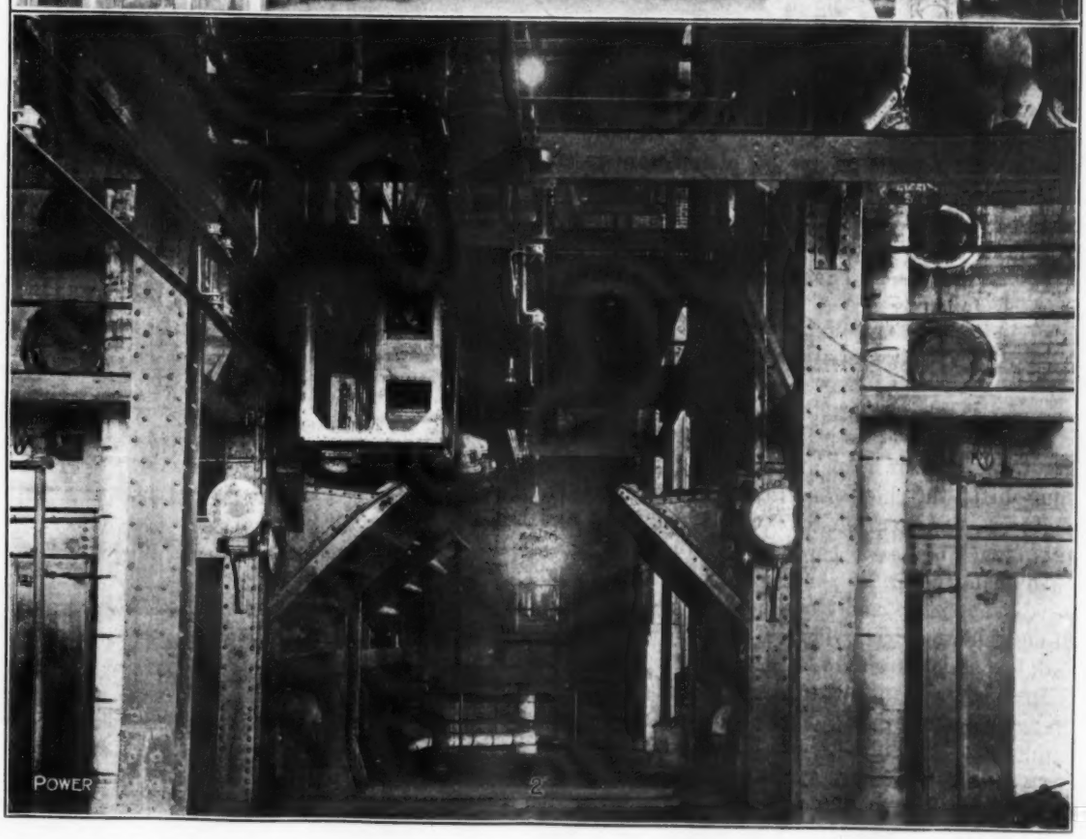
A sub-nipple is a substitute nipple, or, in other words, a short pipe with different styles of thread on its ends.

A swage nipple is a reducing nipple, having one end smaller than the other.

A long screw nipple is made up of a short length of pipe; one end has a standard thread, the other is threaded far enough to allow a coupling and lock-nut to be turned by hand without overlapping the pipe end. It is an advantage when making a connection, or for connecting pipes in place.

Coal-Weighing Larries

The Cleveland municipal electric-light plant uses two Brownhoist coal-weighing larries to transport the coal from the bin to the stokers and weigh each load (Fig. 1). The plant is equipped with a large coal bin arranged with four rows of hoppers, each fitted with a Brownhoist air-operated gate, and each separately controlled by an air valve located along the crane runway within reach of the larry operator when the larry is stopped beneath the gate. The air cylinder is swiveled so that it will adjust itself to the different positions of the piston while the gate is in the act of opening and closing.



Each larry operates with a transfer crane which travels along a runway beneath two rows of the gates. The larries reach the other two rows of gates by individual tracks. The transfer crane is operated from the larry. The operator brings the transfer crane into alignment with the tracks running to the stokers or to the farthest coal gates and the larry runs off the crane onto these tracks after a locking device is set to keep the crane in alignment with the tracks. Fig. 2 shows the larry delivering coal to the stokers. Each electrically operated larry is of two-ton capacity. Two gates are provided through which the coal flows onto a belt which throws it into the hoppers.

The larries and cranes are equipped with brakes, and ail open ends on the tracks are provided with safety stops to prevent the larries running off. Each larry is equipped with scales, with the scale beam in the operator's cab. The operator keeps a record of all coal delivered to the stokers.

The Wages of Engineers

By Earl Pagett

Much has been written about the compensation received by engineers. As data on the salary drawn by engineers are noticeably lacking, the writer set out to collect the facts from the men themselves by a letter sent to engineers in widely separated sections of the United States. Of the seventy-five letters sent out, many came back and a number were not answered. It is regrettable that a greater number of places could not be heard from.

The following table shows the data as collected:

Place	Size of Plant, Hp.	No. of Men: Chief	No. of Men: Ass't	Hr. per Week: Chief	Hr. per Week: Ass't	Salary per Week: Chief	Salary per Week: Ass't
Cambridge, Mass.....	25,000	1	4	56		$45.00	$26.50
	600	1	3	56		40.00	25.00
	400	1	3	56		35.00	25.00
	300	1	3	56		31.25	18.00
	500	1	1	60		35.00	23.00
				Chief	Ass't		
Baltimore, Md.....	1,000	1	1	66		25.00	17.50
	600	1	2	54	72	30.75	17.50
	400	1	1	66	78	25.00	19.50
	400	1	2	54	72	25.00	17.50
	800	1	2	54	72	25.00	18.25
Hyattsville, Md.....	700	1	3	56	56	34.60	23.00
	700	1	3	56	56	38.45	21.00
	450	1	2	56	56	30.75	20.75
	100f. oil	1	0	56	72	23.00	
	100	1	0	70	84	23.00	
						Salary per Month	
Clay Center, Ohio.....	5,000	1	2	70	84	$125	$85
	not stated	1	1	84	84	100	96
	700	1	1	84	84	75	70
Laramie, Wyo.....	700	1	4	70	70	100	95
Lisbon, Ohio.....	12,000	1	3	56	56	100	80
	1,000	1	3	56	56	110	80
	10,000	1	3	56	56	125	90
	6,000	1	2	84	84	90	80
Louisville, Ky.....	15,000	1	2	84	84	160	125
	1,200	1	3	48	48	150	78
	300	1	3	56	56	100	90
	300	1	1	60	60	108	78
	100	1	1	72	72	108	65
Exeter, Neb.....	225	1	1	54	54	90	70
	250	1	1	54	54	100	70

The standard rate for the mining districts of the Southwest does not vary greatly over a wide range of plant size. Chief engineers get from $150 to $200 a month, sometimes including house, light and water. Watch engineers receive from $125 to $150 a month; eight hours is considered a watch and thirty and thirty-one days a month. No reports on special plants were received.

Memphis, Tenn.: No report on special plants. The correspondent states that chief engineers average about $125 and assistants about $75 a month.

Foxboro, Mass.: The wages in this vicinity will average as follows:

	Per Week
First-class engineers	$23 to $30
Second-class engineers	18 to 23
Third-class engineers	15 to 21
Firemen	14 to 17
Hours worked will average	55 to 60

Framingham, Mass.: In plants of from 1000 to 5000 kw. three or four men are employed, working in eight-hour shifts, the chief sometimes standing a watch. Chief engineers receive from $25 to $35 per week and assistants from $18 to $25 per week.

In manufacturing plants of from 1000 to 2000 hp., usually one chief and three operating men are employed in eight-hour shifts. The chiefs get about $30 per week and the assistants from $18 to $24.

In smaller manufacturing plants of from 100 to 500 hp., one engineer and a day and a night fireman are employed. The engineer works 60 hours per week, spends from two to five hours at the plant on Sundays, and receives from $18 to $26 per week. Plants smaller than this pay from $15 to $18 per week of about 60 hours.

Large brewery plants in this vicinity pay about $35 per week for the chief engineer and $21 to $25 for the assistants; engineers work in eight-hour shifts.

South Chicago, Ill.: Information on one plant only. The men work six 12-hour shifts and change every week. First assistants get $4 per day, second assistants $3.50 and third, $3; oilers and stokers, $2.50 per day; chief engineer's salary not given.

Norman, Okla.: Plant of 250 hp., one day and one night engineer; 84 hours per week with $100 and $80 per month respectively. Pumping plant, one engineer at $1200 per year. Plant with three boilers and one 125-kw. generating set; one chief and two assistants on eight-hour shifts; chief receives $1000 a year, assistants $70 to $75 a month. Plant of 150 hp.; one chief, who is also superintendent of machinery, at $1200 per year.

New Orleans, La.: Chief engineers of ice and cold-storage plants, $100 to $200 per month, subject to call at any hour; assistants, $75 to $85 a month, 84 hours a week. No report on other plants.

Wichita, Kan.: Only one plant reported; 8750-kw.; one chief engineer and three assistants, each working 56 hours per week. The chief gets $125 a month and the assistants $75.

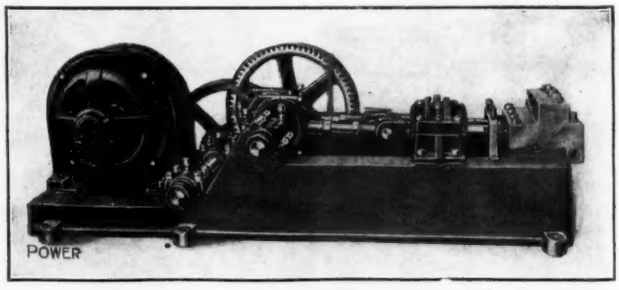
Coffeyville, Kan.: Plant of 900 kw., one chief engineer and two assistants on eight-hour shifts. The chief gets $100, assistants $75 per month. Plant of 400 kw.; one chief engineer, three assistants on nine-hour shifts. The chief gets $150 and the assistants $75 per month. Plant of 700 hp.; one chief working 70 to 77 hours per week at $95 a month. Plant of 150 hp.; one day and one night engineer on 12-hour shifts; day man gets $3 and the night man $2.50 per day. The day man washes the boilers on Sundays. Plant of 300 hp.; one day engineer, working 84 hours a week at $100 a month. The watchman cares for the plant at night.

There seems to be a wide variation in the wages paid in similar plants. Take the plant of 600 hp. in the vicinity of Cambridge, Mass.; it pays the chief engineer $160 a month, working 56 hours a week, while in the vicinity of Clay Center, Ohio, a plant of 500 kw. pays the chief engineer $75 a month for 84 hours a week.

It would seem that if it is worth $160 a month to run a plant in one place, it should be worth at least that much to run a similar plant almost any place.

Watson-Stillman Triplex Hydraulic Pump

The Watson-Stillman Co., 50 Church St., New York City, has added to its line a new type of motor-driven



Triplex Hydraulic Pump, Motor Driven

geared, triplex, single-acting pump. While primarily designed to meet the severe demands of tunnel service, it will be equally suitable for other conditions.

To secure compactness, rigidity and alignment of the working parts when under severe service, the motor is mounted on an extension of the heavy cast-iron base. The driving shaft and bearings are large and are provided with lubricating cups. The gears are of the heavy cut-tooth type. The drive from the shaft is by eccentrics set at 120 deg. cast in one piece and keyed with one key to the driving shaft. The eccentric straps are heavy.

The plungers are of tool steel and are guided in a cross-head guide, which is keyed and bolted to the base.

The pump body is a steel forging fitted with bronze valves and bonnets. All passageways are made large to reduce the friction of the water to a minimum. The pump, shown herewith, is operated by a 10-hp. motor running at 600 r.p.m., and delivers 100 cu.in. of water per minute at 3500 lb. pressure, with a crankshaft speed of 100 r.p.m. Other sizes of the pump are built to suit operating conditions.

Installation and Care of Fire-Protection Apparatus

By J. O. Benefiel

Usually, such apparatus is installed under the supervision of an insurance company, but it often happens that additional buildings are erected requiring automatic sprinklers, and the engineer should be able to plan and supervise the extensions satisfactorily, thus saving his employers considerable expense.

One thing he should avoid is getting too many sprinklers on one branch line. The distance from the wall to the first sprinkler should not be more than half the distance between sprinklers in the same direction. Under a pitch roof one line of sprinklers should be in the peak. Splash plates should not be less than three nor more than ten inches from joists or ceilings. All stairways, closets and odd corners should be looked after.

LOCATION AND SPACING OF SPRINKLERS (FROM THE RULES AND REGULATIONS OF THE ASSOCIATED FACTORY MUTUAL INSURANCE CO.)

One Row of Automatics Placed Midway between Beams in Each Bay		Water Pressure at Highest Sprinkler Exceeding 20 Lb.		Less Than 20 Lb.	
		Medium Hazard	Special Hazard	Medium Hazard	Special Hazard
In 12-ft. bays	Sprinklers:	8 ft. apart	7 ft. apart	7 ft. apart	6 ft. apart
In 11-ft. bays	Sprinklers:	9	8	8	7
In 10-ft. bays	Sprinklers:	10	9	9	8
In 9-ft. bays	Sprinklers:	11	10	10	9
In 8-ft. bays	Sprinklers:	12	11	11	10
In 7-ft. bays	Sprinklers:	12	11	11	10
In 6-ft. bays	Sprinklers:	12	11	11	10

The terms "medium" and "special hazard," in the table, relate to the contents or occupancy of each room. Especially hazardous places are picker rooms, sawing departments of wood-working plants and varnish rooms.

The following tabulation gives the maximum number of sprinklers to be supplied by the sizes of pipe given:

Size of Pipe, In.	No. of Sprinklers	Size of Pipe, In.	No. of Sprinklers
¾	1	3	36
1	2	3½	55
1¼	3	4	80
1½	5	4½	110
2	10	5	140
2½	20	6	200

Supporting the branch pipes by hangers in rooms where there is much heat or steam is a serious problem. Another annoyance is leakage around the valve stems.

The swing checks on the inlet from city mains and the discharge from the fire pump sometimes stick open when the spindle on which the check swings is iron and corrodes. All moving valve parts should be made of brass.

In rooms where certain processes are carried on, the sprinklers should be taken off and cleaned whenever they become coated with deposits.

During the regular overhauling in a certain plant the disks of the 2-in. drain valves are taken out, cleaned, and a ring of gasket rubber is put on the disk to prevent a leakage which would cause a loss of the water seal on top of the dry valve.

To those not acquainted with the valves it is explained that the upper (sprinkler) side of these valves has about five times the area exposed to the air pressure to hold it shut to one on the lower side subjected to water pressure. About 35 lb. of air is usually carried to balance 100 lb. water pressure. When a sprinkler head acts, the air pressure is reduced and the water-supply valve opens. The system then fills with water. After being in action it is necessary to again put the system in order. All the

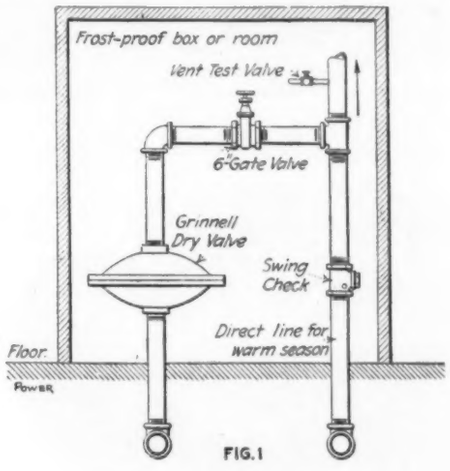


FIG. 1

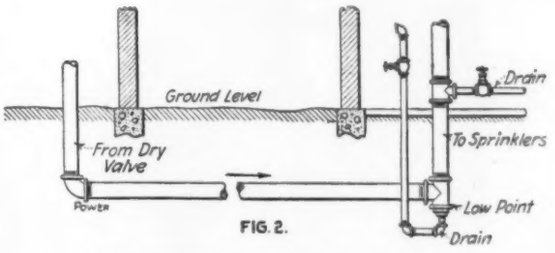


FIG. 2.

Underground Section of Line

drains are opened to let the water out to the test valve above the tee shown, Fig. 1.

All the drains are then closed and from forty to fifty pounds of air pressure is put on the system. One man goes around opening the drains, one at a time, until they show no water. The air pressure is then brought up to about thirty-five pounds and the valve in the yard is opened to let the water pressure against the under side of the dry valve. The drains should be opened about twice a week for two or three weeks to make sure the system is free of water.

If the building is warm during the day and cold at nights and on Sunday, an allowance must be made for a loss of pressure due to the air contracting in the pipes.

Fig. 2 shows a drop underground to another building. The draining of the underground section was a problem, there being no sewer. It was done by bringing the drain to the surface, as shown, and blowing the water out by air. It has worked successfully for years and has but one drawback—so much talking must be done to convince each new inspector that it works.

Interesting Power-Plant Apparatus

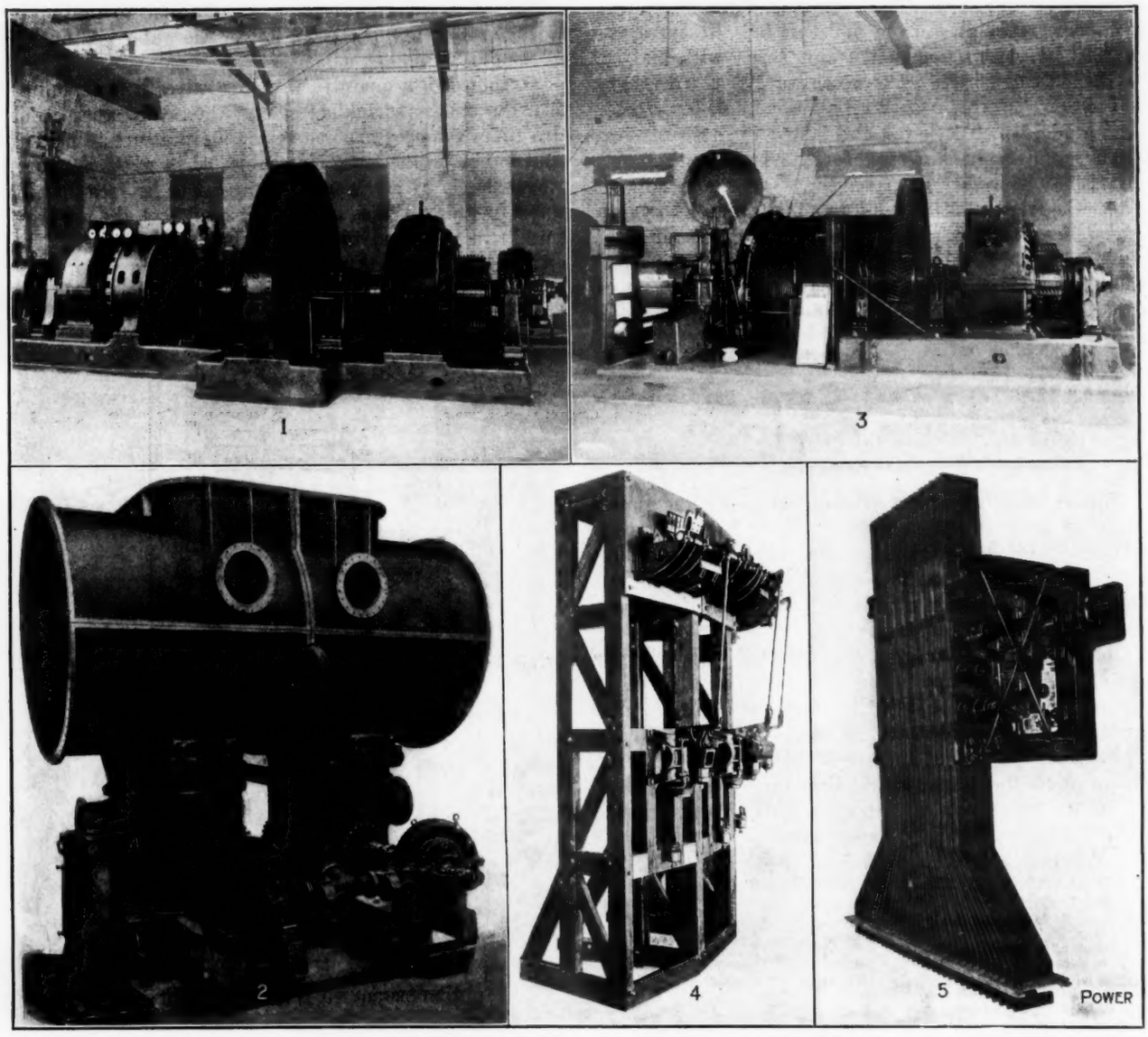


Fig. 1 shows a Wellman-Seaver-Morgan Co. duplex motor-generator flywheel set consisting of a 350-hp. motor driving one 400-kw. and one 200-kw. direct-current, 550-volt generator running at 720 r.p.m. At one end of the shaft there is attached a direct-current exciting unit. The flywheel weighs 25,000 lb.

This machine, which is used by the Cleveland Cliffs Iron Co., acts as a balancing set and furnishes direct-current to a main ore hoist and to a man-and-timber hoist. Fig. 3 is a geared hoist with a single drum for hoisting men and timber in a single 1300-ft. compartment shaft, the counterbalance being obtained by the use of counterweights. The machine is geared to produce a hoisting speed of 1000 ft. per min.

The drum is 96 in. diameter by 84 in. face, and is grooved for a 1¼-in. rope. A 96-in. diameter band brake is on one end of the drum. The double-acting brake is applied by gravity and is released by means of a combined air and cataract cylinder. The gears are of the herringbone or helical type. The electrical equipment consists of a 500-volt, 200-hp. direct-current motor running at 250 r.p.m. and receiving its current from the duplex motor-generator set, Fig. 1.

Fig. 2 is a large jet condenser with a small jet condenser in the foreground. The large unit is in use at the Westport plant of the Consolidated Gas, Electric Light & Power Co., Baltimore, Md., with a 15,000-kw. turbo-generator. This condenser takes care of 200,000 lb. of steam per hour to a 28½-in. vacuum with 70 deg. F. injection water.

The small condenser shown is used with turbines up to 300 kw. capacity. This particular unit takes care of a low-pressure turbine of 100 kw. capacity.

In both condensers the same general idea is worked out; viz., the air- and water-removal pumps being on the one shaft, either turbine or motor driven, the removal pump being submerged in the tank base of the condenser. Both units have substantially the same water distribution and are of the parallel-flow design.

Fig. 4 is a 12,000-amp., 600-volt circuit-breaker, the largest capacity alternating-current circuit-breaker in the world. It is in the Wood Worsted Mills, Lawrence, Mass., the largest worsted mills known.

Fig. 5 illustrates a 40,000-amp., motor-operated switch for electric furnace. The output of the furnace is either 20,000 amp. with a potential of 40 volts, or 40,000 amp. with a potential of 20 volts. The weight of the switch is 7193½ lb. In the construction of this switch 5268 lb. of copper was used, over 2½ tons; 871 lb. of composition metal; 681 lb. of cast iron; 342 lb. of steel and 31½ lb. of mica. This switch was manufactured by the General Electric Co., Schenectady, N. Y., as was the 600-volt circuit-breaker.

Editorials

The Year's Review

In 1913 the word "large" best defined the tendencies of development, and the impetus gained in this period has carried over into the year just past. Notwithstanding the general depression in business, installations were made in which some of the equipment holds first place in size or capacity. Long ago the advantages of concentration were appreciated and the constantly growing demands have urged the manufacturer to greater efforts. Each year something bigger than ever before makes its appearance and apparently only raises the horizon for the particular field concerned.

In looking over the files for the year the first large device to attract attention is a Mesta triple staggered-tooth spur gear, 22 ft. 8 in. in diameter, having a 38-in. face and 154 teeth spaced on 5½-in. circular pitch. It was built to drive a sheet mill of the Inland Steel Co., and at a speed of 2000 ft. per min. the gear transmits 1600 hp.

For the Woodward Iron Co. two horizontal cross-compound Mesta blowing engines, 48 and 84 by 60 in., were installed. A notable feature was the building of one engine in 38 days and the completion of both in 59 days. The Nichols Copper Co., Long Island City, has the largest Keeler water-tube boiler ever built. The boiler is rated at 1280 hp. and has a little more than half the capacity of the Stirling boilers now being installed at the new Connors Creek station of the Detroit Edison. It will be remembered that these boilers are rated at 2350 boiler-horsepower, and by forcing are capable of carrying continuously the enormous load of 13,300 kw. Normally, they are designed to care for 10,000 kw.

In cooling towers there have been three large installations: one a twin Wheeler-Barnard forced-draft tower for the American Hardware Co., New Britain, Conn., capable of cooling 132,000 gal. of water per hour from 100 to 80 deg. F.; a battery of towers of the same type to cool 600,000 gal. of water per hour for the Texas Power Co., Waco, and a Mitchell-Tappen atmospheric tower capable of cooling 120,000 gal. per hour through the range previously given. The tower last mentioned was installed for the main power house of the South West Missouri Railroad Co., at Webb City, Mo.

A notable pump installation was made for the Plaquemine & Jefferson Drainage District of Louisiana, consisting of four 76-in. and one 48-in. centrifugal pumps built by the Southwark Foundry & Machine Co. The larger pumps each have a capacity of 168,000 gal. per min. (over 10,000,000 gal. per hr.), at 1-ft. head and 40,000 gal. per min. against a head of 13 ft., and are used to pump water back over the levee into the Mississippi River. The 100-million gal. De Laval centrifugal pump recently installed at Pittsburgh has a 48-in. outlet, but it must raise the water against a total head of 56 ft. Another interesting installation is the first large American-built Humphrey gas pump which is to be used for irrigation purposes near Del Rio, Texas. The cylinder is 66 in. in diameter and is supplied with gas by a 300-hp. Akerlund down-draft producer capable of gasifying either soft coal or mesquite wood.

The Alabama Power Co. has recently installed the first of four 17,500-hp. generating units at its hydro-electric station on the Coosa River. The turbine is the largest of the single-runner type in operation. To the Brooklyn Edison must be credited the largest single-cylinder steam turbine. It is rated at 22,000 kw. and with a moderate temperature rise it is expected to carry 25,000 kw.

Recently the first car containing parts of the mammoth direct-current generators for the Ford plant in Detroit left the works of the Crocker-Wheeler Co. Each of the four machines is to have a normal capacity of 3750 kw. and will weigh 105 tons. The field frame is 21 ft. high and 26 ft. wide across the supporting feet. The armature is 16 ft. in diameter and weighs 87,000 lb. As this dimension exceeded the limits for track clearance the assembling of the armature parts and the winding must be done in Detroit.

Another event worth noting in the electrical field is the completion of the longest transmission line by the Southern Sierras Power Co. It extends 400 miles from the generating station to the most distant customer, but the main straight-away transmission is not as long as that of the Big Creek system.

Credit for the largest Diesel engine built in this country to date belongs to the Lyons Atlas Co., Indianapolis. It has four 21x30-in. cylinders, which will develop normally 600 hp. and a maximum of 690 hp. driving a two-stage turbine pump of 15 million gal. capacity against a head of 200 ft. The unit will be used by the Hawaiian Commercial & Sugar Co. for irrigation purposes.

Valves for steam headers which weigh 3600 and 3900 lb., respectively, are not common. In fact, the Nelson valves of the above weights recently furnished the New York Edison Co. are claimed to be the largest steel gate valves for superheated steam yet installed. When open they measure 9 ft. 1 in. from the bottom of the body to the top of the stem. The valves are to be mounted in 18-in. steam leads, carrying steam under 200 lb. pressure and 150 deg. superheat.

Steam Turbines

Of the various large turbines building for Chicago, New York, Philadelphia and elsewhere, perhaps the most interesting is the 35,000-kw. unit for the Philadelphia Electric Co., as it is the largest in the world by 5000 kw. The prime mover is a thirteen-stage horizontal Curtis turbine 63 ft. 2 in. long over all, 21 ft. 7 in. wide and 15 ft. 10 in. high. The weight of the unit is 600 tons. It will receive steam at 215 lb. pressure and 150 deg. superheat and exhaust against an absolute pressure of 1.5 in. of mercury. At the most economical load, 25,000 kw., it is expected to develop a kilowatt-hour on 11.9 lb. of steam. At the full rated load of 35,000 kw. the water rate increases to 12.6 lb. per unit. With a better vacuum the steam consumption will be lowered slightly. The condenser for this immense unit is naturally the largest in the field. It is of the center-flow surface type

containing 50,000 sq.ft. of surface in 1-in. tubes. This reduces to 1.43 sq.ft. per kilowatt of turbine rating, which may be compared to an average of 3 sq.ft. a few years ago. That injection water is supplied through a 48-in. pipe will give some indication of the quantity required. The auxiliaries are all turbine-driven centrifugal units, and the air pumps are the Le Blanc type. The generator delivers three-phase 60-cycle currents at 13,200 volts. The speed is 1200 r.p.m. The station is to contain also a 30,000-kw. unit of the same type which will deliver 25-cycle current with the same expenditure of steam at the most economical load, 22,500 kw. The speed will be 1500 r.p.m.

When the above water rate is compared to the guarantee for the 25,000-kw. Parsons turbine at Fisk Station, of 11.25 lb. per kw.-hr. against a back pressure of 1 in. of mercury, it will be seen that there is little if any difference in economy between the two machines. It may be of interest to state that this English unit is now in satisfactory operation. The troubles usually encountered when starting a machine of a type new to the station, and other troubles due to damaged insulation, have been overcome.

As previously stated in these columns, this unit is of the two-cylinder tandem type; the Brooklyn Gold St. turbine has but a single cylinder, while the 30,000-kw. Interborough turbines have two cylinders arranged cross-compound and operating at different speeds. Several advantages are claimed for the compound units such as a smaller temperature range in each cylinder, the possibility of separating the moisture midway in the expansion of the steam, smaller cylinder structure and the reduction of stress set up by wide temperature ranges. In the single-cylinder turbine this is offset by a machine which takes about three-fifths the floor space occupied by the tandem compound and a still lower fraction of the space taken by the cross-compound. The water rates do not vary appreciably. The action of the Brooklyn turbine in practice will no doubt help to determine the limits of a single cylinder.

In this same turbine the stationary blading for the high- and intermediate-pressure sections is not fastened to the casing but is mounted on cylinders set into it. This practice is being followed in other large turbines as it has been found desirable from the standpoint of convenience and strength. An increase in the speed of these large units is also a point of interest. The earlier of the large turbines were designed for 750 r.p.m.; the Brooklyn unit makes 1500 turns per minute, and some 20,000-kv.-a. turbines now being built for the Public Service Corporation of New Jersey are to run at 1800 r.p.m.

A serious difficulty tending to limit the capacity of these great machines is the problem of utilizing effectively the immense volumes of steam in the lower stages. The struggle to obtain greater peripheral velocity for the final stages and greater section through them so as to maintain the most efficient ratio between steam and blade velocity has resulted in a number of suggestions such as a considerable increase in the diameter of the final elements, a combination of velocity, pressure-impulse and reaction stages and other arrangements tending toward the same end, as discussed quite recently in these pages.

Engine Progress

For several years the tendency has been toward higher speeds and consequently engines of less weight which require less excavation and concrete and give more room for purposes other than power generation. By the use of higher pressures and some superheat, water rates have been lowered, although the longevity and low upkeep of the Corliss have been sacrificed to some extent. The reduction in initial cylinder condensation by the adoption of the una-flow principle has boosted the economy of condensing engines. With pressures ranging from 300 to 500 lb. there are great possibilities for the above type. Already results obtained from one cylinder equal those from the average compound, and the ultimate goal is an economy approaching that of the Diesel engine.

In this connection it may be of interest to state that the year has seen the first una-flow engine built in America under the patents of Professor Stumpf and the personal supervision of his representative. A 15x16-in. engine designed to carry 100 kw. and running at 250 r.p.m. under a steam pressure of 145 lb., a superheat of 88 deg. and a vacuum of 25½ in. developed an indicated horsepower-hour on 12.5 lb. of steam. The lowest noncondensing rate with steam superheated 130 deg. was 16.8 lb. and with saturated steam, 20.4 lb. It is evident that the una-flow is primarily intended to operate condensing. Another design of una-flow engine has been perfected by the Skinner Engine Co. with practically the same noncondensing steam rates, and the Nordberg Co. has produced a una-flow engine with poppet valves to supersede, for high pressures and superheats, its previous design employing Corliss valves. The same company has also improved its poppet-valve engine by locating the valve seats in the heads and operating the valves mechanically instead of depending on a spring for the return movement.

The first Buckeye-mobile in commercial service is a feature of the year. This particular unit is rated at 115 hp. and is directly coupled to a 75-kw. alternator at the works of the International Cork Co., Greenpoint, L. I. It occupies a floor space 17 ft. 10 in. long by 7 ft. 6 in. wide. From the base to the top of the flywheels the unit stands 9 ft. high. In its shop test the engine, which is compounded, developed a steam rate of 13.3 lb. per i.hp.-hr. on 1.33 lb. of coal. The boiler pressure was 210 lb. and the superheat 171 deg.

Boilers

The practice of forcing boilers for the peak load to double and, in some cases, triple their rating is becoming more firmly established. Where formerly it was customary to provide a boiler-horsepower for every kilowatt of generating capacity, a ratio of 1 to 4 is now common in the larger stations. Lower water rates, of course, help in this direction. In the new generating plant of the United Electric Light & Power Co., of New York, commonly known as the 201st St. Station, which was officially put in commission on Jan. 31, one boiler-horsepower is expected to care for 4.7 kw. At Waterside No. 2, the ratio of boiler-horsepower actually used to installed generator capacity is 1 to 4.2 and in emergencies at Delray one boiler-horsepower will supply 5.65 kw. This necessitates a more extended use of forced draft, although in Boston a natural-draft plant with some cheap means, such as steam jets, of materially increasing the draft during peak loads, is considered the ideal installation.

The amount above normal rating at which a boiler can be safely operated depends largely upon the scale-forming and suspended matter in the feed-water. In quite a

number of the larger stations where boilers are forced to several times their ratings, the use of distilled water is being considered. The cost would not be great, as the make-up in a "tight" plant is only a small percentage of the feed. Some doubts as to the corrosive effect of distilled water are prevalent, but its use for years in marine plants has failed to reveal any serious trouble.

A startling suggestion brought forward this year by W. L. R. Emmet, of the General Electric Co., is the use of mercury as a working fluid for heat engines. The project has taken more definite form than a mere proposal, as experimental work has been conducted for some time and the installation of a 100-hp. unit at Schenectady was completed some nine months ago. A mercury boiler supplies vapor to a turbine. The latter exhausts to a condensing boiler which generates steam for another turbine on the same shaft. The mercury is, of course, returned to its respective boiler. The advantage of using mercury lies in its ability to utilize much higher temperatures without excessive pressures. At atmospheric pressure mercury boils at 677 deg. F. and condenses in a 28-in. vacuum at 455 deg. The density of its vapor is another advantage permitting in a turbine the use of much shorter blading in the low-pressure stages. Comparing the system to the ordinary steam plant, Mr. Emmet estimates a gain of 66 per cent. in delivered power at an additional fuel expenditure of 15 per cent. About $10 worth of this new medium will be needed per kilowatt of mercury turbine.

In Europe, high-voltage, alternating-current electric boilers have been in use for a number of years. These boilers take the primary current and may be used to generate steam for heating or commercial purposes, to keep the water hot in boilers of a steam reserve plant or to maintain reserve water units in operation, which may be switched into service on the line at a moment's notice. The first plant on this side of the Atlantic was installed this year in eastern Canada. It consists of two single units of 750 kw. each, operating on 2400-volt, three-phase current to generate steam of 125 lb. pressure for heating a cotton mill during night hours. It is estimated that one kilowatt-hour will produce about three pounds of saturated steam at pressures up to 125 lb.

A new sectional water-tube boiler in which one large circulating pipe conveys all of the water from each drum to the bottom of the header sections has been perfected by A. Venning, Preston, Ont. T. T. Parker, New York, has patented a cross-drum water-tube boiler with several novel features, and quite recently the possibilities of the high-pressure Winslow boiler have been brought to the attention of the engineering fraternity.

In locomotive practice in the past year the Crawford stoker has shown wonderful possibilities for heavy freight and transfer as well as fast passenger service. Rates of combustion as high as 200 lb. of coal per square foot of grate per hour have been obtained.

Marine Tendencies

Relative to development in the marine field the Talbot and the Niclausse boilers have been improved with a view to bettering the circulation and as a natural consequence the efficiency. The new Ward wrought-steel, water-tube boiler for marine purposes is also a product of the year.

On Feb. 26 the "Britannic" was launched. In spite of the war, the White Star Line expects to put this 50,000-ton liner in service in 1915. She is 900 ft. long, which may be compared to 882 ft. 9 in. for her predecessor, the "Olympic." The extreme breadth is 94 ft. and the displacement at a load draft of 34 ft. 7 in. is 53,000 tons. The displacement of the "Olympic" when drawing 34 ft. 6 in. is 3000 tons less. Chief interest centers in her machinery. Three-screw propulsion is effected by four-cylinder, triple-expansion engines, 54, 84, 97 and 97 by 75 in., on the wing screws and a low-pressure turbine on the center screw. The latter will receive steam at about nine pounds absolute pressure and exhaust into condensers at one pound absolute. At 165 r.p.m. the turbine will develop more than 16,000 hp. The great advantage of such equipment is that the machinery can be worked at reduced power with practically the same efficiency as at full load.

The annual report of Lloyd's Register, recently issued for the year ending June 30, 1914, calls attention to the increasing use of steam turbines, and especially those which are geared to the propeller. At present there are 23 vessels now being built under Lloyd's classification in which geared turbines are to be fitted, six vessels which will use direct turbine drive and six which will have the three-screw combination installed in the "Britannic." Employing the reduction gear allows both turbine and propeller to be driven at speeds most efficient for each. The U. S. Collier "Neptune" has shown the adaptability of reduction gears, and with the higher turbine and lower propeller speeds suggested by the original trials, good results are expected.

In the U. S. Collier "Jupiter" electric drive was installed. In the year and a half in which she has been in commmission she has steamed about 14,000 miles and has been thoroughly tested under all conditions of service. The speed of the nine-stage Curtis turbine is 1990 r.p.m. and of the two induction motors driving the propellers, 110 r.p.m. In showing an economy from 20 to 25 per cent. greater than her sister ships, the boat has more than vindicated the claims of the designers. As a result the Navy Department has decided to equip the battleship "California" with electric drive.

Another feature mentioned in the report was the increasing use of large Diesel-engine motor ships. At present 27 vessels holding Lloyd's classification have an aggregate of 50,000 i.hp. in Diesel engines, and there are twenty more now building.

Coal and Smoke

For a long series of years the coal produced in this country has doubled every decade. For the past year the estimated production is 550 million tons, or about 5 tons per capita. At this alarming rate, increasing with each succeeding year, the supply will be exhausted at no distant date. Conservation of the supply is thus becoming more urgent. While the cheapness of the fuel has discouraged concentrated effort, some progress has been made. Classification of the coal is finding a constantly widening field of application, the obstacles common to the burning of powdered coal are being overcome and the washing and sizing of Western coals is resulting in a decided gain. Such plants as the one installed this year at Hauto, Penn., utilize what was formerly a waste at the mines, and in supplying the surrounding territory with electric energy conserve the supply of coal worth shipping.

Considerable progress has also been made in smoke suppression. Most of the large cities in the country are now actively engaged in abating this nuisance, although there

is a general hesitancy in appropriating sufficient funds for the purpose. Pittsburgh in particular has become more active in the past year. The city is the largest consumer of bituminous coal in the world and its annual soot fall has reached the enormous figure of 1031 tons per square mile. Truly the opportunities for "cleaning up" are great, and with the incentive awakened surprising results may be expected.

Europe is also awaking to the possibilities of smoke prevention. Twenty-four English and Scotch cities are making soot observations with standardized apparatus and methods. Educational classes for engineers and firemen have been started with a view to teaching them improved methods of burning coal. Progress is necessarily slow, because of the limited powers conferred by existing laws and because societies for the suppression of smoke are dependent upon membership fees and donations for the funds required to carry on the work. Finland is active in smoke abatement and Hamburg has a smoke-prevention society made up of manufacturers to the number of 473. The society is a voluntary association of large consumers of fuel bound together by the common interest of reducing smoke and bettering the efficiency of their boilers.

Electrical Advancement

Oct. 21 last commemorated the thirty-fifth anniversary of the invention of the incandescent lamp. On the above date in 1879 Thomas A. Edison first successfully made a carbon filament glow. It was the beginning of interior electric lighting in small units, the arc having preceded the incandescent by a few years, although to a limited extent.

Perhaps the most notable development in switchboards was that for the control of the Panama Canal Locks, which was completed during the early part of the year. The 35,000-kw. generator for the Philadelphia Electric Co. has already been mentioned. Among the more special apparatus is the Kapp phase advancer. It consists of three small, direct-current motors connected in circuit with the rotor of an induction motor. The small machines set up an electromotive force in opposition to that produced by the slip of the rotor and in this way increase the power factor to unity or above.

In England and on the Continent considerable attention has been given to this problem of phase advancing. In the former country an installation in connection with a 330-hp. induction motor has been made quite recently. A new method of self-synchronizing rotary converters has been developed and is being extensively adopted by British manufacturers. The General Electric Co. has perfected a revolving compensator with one collector ring for obtaining the neutral connection with three-wire operation. It is to supersede the familiar separate stationary compensator and two-collector-ring arrangement.

The use of synchronous condensers of large capacity for voltage regulation as well as power-factor correction has been introduced in connection with the Big Creek development of the Pacific Light & Power Corporation. It may be recalled that this company employs the highest transmission voltage yet attempted, 150,000 volts. Outdoor substations continue to grow in popularity and the practice of washing air for cooling electrical apparatus has become more general during the past year. Improvements have been made in oil switches for meeting the general tendency toward higher voltages, and more satisfactory designs of power-limiting reactances have been developed. Equally important with the development of new devices is a set of safety rules governing the use of electrical apparatus, which has been compiled during the past year by the Bureau of Standards. A radical revision of the old rules was made in the basis of rating machinery. From a thermal standpoint a rating no longer is established by a standard rise in temperature under prescribed conditions of load but the hottest spot in the insulation is made the deciding factor. There is no provision for overloads causing a temperature higher than specified. The owner must take all risks if he desires to exceed the limit.

Gas and Oil Engines

In the gas-power field there has been little new in producer work or in gas-engine developments. Ehrhardt and Sehmer of Saarbrucken, Germany, have increased the power, and incidentally the efficiency, of their engines by thoroughly scavenging the burnt gases and introducing the fresh charge under pressure. A blower driven by a motor or by a turbine supplied with steam from a waste-heat boiler delivers the air and gas under a pressure of 10 to 15 lb. Due to the lower temperature from scavenging and to the pressure, a heavier charge and a better mixture of live gas are obtained. The effect is to raise the mean effective pressure and to improve conditions generally.

A distinctive advance has been made in the recovery of waste heat from gas engines through the Merriam process, as developed by the Bruce-Macbeth Co. By forcing the water in a closed circuit through the jackets at a velocity five to ten times normal, the temperature can be raised to 300 deg. without endangering the cylinder. Thus steam under pressures as high as 50 lb. can be generated and the heat usually wasted in the jackets is utilized.

During the past year important experiments have been conducted by the Engineering Experiment Station of the Pennsylvania State College to determine the applicability of kerosene, alcohol, motor spirits and mixtures of gasoline and kerosene as substitutes for gasoline in engines, also the effect of water injection with these different fuels. Some interesting results were obtained and it is evident that these investigations are timely, for in the United States alone in 1914 it is estimated that 25 million gallons of gasoline was consumed.

The immense combination steam-gas engines for the Ford Co. are nearing completion. The large Humphrey pump has been given mention. During the year several firms have started to build Diesel and semi-Diesel oil engines and several oil engines of the two-cycle, heavy-duty type have been put on the market. An interesting innovation in the delivery of oil fuel has been introduced by the government at Fort Baker, Calif. Oil is piped through the streets in the same way as water and gas. It is delivered to residences and other buildings at 30 lb. pressure for use in furnaces, for heating and cooking and in oil engines for power. This installation and the one at the Presidio, San Francisco, are believed to be the first of their kind ever attempted on a large scale.

Water Power

During the past few years the Pacific Coast has come forward with a greater increase in water-power development than any other section of the United States. Immense projects have been completed recently and others are in prospect, but even with the rapid progress that has

been made only 7 per cent. of the total potential water power in the three Coast states has been developed. Tennessee, Georgia, the Carolinas and Minnesota have also been active. During the year the low-head 10,500-hp. development at Coon Rapids, which is to serve Minneapolis, was put into commission. The recent agreement between the Secretary of Agriculture and the state water commission of California on the use of water-powers within the national forests will facilitate developments in this territory. The Adamson bill, which passed the House of Representatives on Aug. 4, was a noteworthy attempt to ward off a monopoly in water power still open to title. The regulation of service and rates was to be left to the states. With this provision the governors in their annual conference at Madison, Wis., were in accord, as they unanimously favored state control of natural resources, notwithstanding their declarations to the contrary in former years.

Engineering Societies

Leading engineering societies of the country are becoming more active than ever before in the interests of their respective fields. As their rosters contain the engineering brains of the country, it is natural to expect that they should formulate standards of design, inspection or testing, and through the exchange of ideas on leading topics guide practice more swiftly into channels of economy and safety. It is gratifying to note that their recent work has been particularly well done and should result in lasting benefit. At a meeting early in the year between representatives of the various engineering societies concerned and the manufacturers' committee, practically all differences between the two schedules of flanged fittings were eliminated. There is still a conflict of opinion concerning the name by which the final schedule shall be known, but a committee has been appointed to smooth out this difference.

The work of the committee appointed by the American Society of Mechanical Engineers to draw up standard specifications for the construction of steam boilers and other pressure vessels and for their care in service has been recorded in these columns. The tentative report of the committee has been sent to leading authorities of the civilized world and at a special meeting all parties interested, including steel and boiler manufacturers, were invited to discuss the report. At the annual meeting held in December it was expected that the committee would be able to present its recommendations revised in the light of the discussions and in final form at the spring meeting in 1915. The report is voluminous and is of the greatest importance to engineers and the public at large, as it involves every item of consequence in relation to the safety of steam boilers, from the specifications of steel to the qualifications of men in the boiler room. The boiler makers have already organized to urge the adoption of these rules by all of the states so that their product may be standardized the country over. Due to the magnitude of the movement more progress with the various state legislatures may be expected in the year to come than in all the years that have gone before.

The report of the power test committee of the same association has now been revised and is being put into final form. Its purpose was to standardize the methods of testing the various types of prime mover and auxiliary apparatus. It will constitute one of the most comprehensive publications ever issued by the society.

Plans for the International Engineering Congress to be held in September of next year at the Exposition are well under way. It is to be conducted under the auspices of five leading national associations and will be presided over by Col. George W. Goethals, who has accepted the office of honorary president.

Boiler Explosions

During the first half of the year 1914 there occurred 340 boiler failures of a more or less serious nature. The number reported killed was 120 and injured 240. The estimated monetary loss was reported in 80 cases only; the total for these was, however, $246,000, making an average of about $3000. The greatest loss, $100,000, was from fire following the boiler explosion. The losses resulting from minor failures are not often given, therefore the average loss is higher than would be the case if all were included. Of the strictly power-plant failures 60 were tube failures, 30 were due to cast-iron headers in water-tube boilers, and 17 blowoff pipes gave way.

Cast-iron heating boilers, as used or neglected, are shown to be a menace of no small proportion. More than 70 are reported to have failed. To repeat a statement of a year ago, "more attention should be given to this type of boiler."

License and Inspection Laws

Relative to the passage of state license and inspection laws, last year's work was barren of results. The National Association of Stationary Engineers continued the work it has been conducting for years, and as usual appropriated funds for this purpose. Fewer legislatures in session and a difficulty in convincing those that were, are the reasons given. To obtain uniform laws the association has offered to coöperate with the American Society of Mechanical Engineers.

In Canada a committee of chief boiler inspectors from the different provinces is drawing up a uniform set of regulations which will be adopted by the entire dominion. During the year rules for the inspection and operation of stationary boilers in the Canal Zone were issued by an executive order of Governor Goethals.

For the safe use and handling of refrigerants the Fire Prevention Bureau of New York City has formulated a set of regulations which went into effect five days ago. Boston also has some ideas on the subject. If regulation is needed in these cities, it is needed in every city or state in the country. The regulations, however, must be sound and safe, and a uniform code is by all means desirable.

Isolated Plant vs. Central Station

The controversy between isolated-plant and central-station interests continues, and no abatement may be expected until the legitimate field for each is more definitely established. Indications, however, point toward progress for the former. Such notable examples as the Ford Buildings in Detroit, the Federal Building in Chicago and many others in which isolated plants have effected large savings are proving beyond the question of a doubt the extravagance of buying current, at a rate profitable to the producer, when heating is to be done. The prolonged delay and final reopening of the Edison rate case in New York City also points in the same direction. Discrimination against the small user of current who cannot compete is having its effect either in a reduction of rates by public service commissions or in crystallizing sentiment toward

municipal ownership. At the meeting of American mayors in Philadelphia last November the sentiment for municipal ownership of all public utilities was remarkably strong. The body was representative of cities large and small from one coast to the other. If the convictions of the mayors are backed by a majority of their respective constituents, city-operated plants should soon be the rule and not the exception. Pasadena, Cleveland, Detroit, in their street and public lighting, and many other cities are showing that a municipal plant is a profitable investment when run on a business basis.

Honor Roll

Last year medals innumerable were awarded for bravery, generalship and what not pertaining to war, but for scientific achievement the only two recipients of which we have knowledge were Prof. John E. Sweet, who was presented the John Fritz medal, and Charles F. Brush, of arc-light fame, with the Edison medal. Earlier in the year the former was given the degree of doctor of engineering by Syracuse University. The honorary degree of master of science was conferred upon Gano Dunn, president of the J. G. White Engineering Corporation, in recognition of accomplishments and distinction in science and electrical engineering. The Nobel prizes were suspended. Of the various national engineering societies in this country closely related to the power-plant field the following men were elected to the presidency: John A. Brashear, American Society of Mechanical Engineers; C. O. Mailloux (second year of term), American Institute of Electrical Engineers; H. H. Scott, National Electric Light Association; F. L. Ray, National Association of Stationary Engineers; Samuel R. Lewis, American Society of Heating and Ventilating Engineers; Louis Doelling, American Society of Refrigerating Engineers.

Necrology

Men of prominence in the field who passed away during the past year are mentioned in the following list: Prof. W. D. Marks, well known in engineering circles; E. E. Nolan and William Cooper, of the Westinghouse Electric & Manufacturing Co.; George J. Weber, former president of the Weber Gas & Gasoline Engine Co.; John C. Kelley, founder and only president of the National Meter Co.; Franklin Phillips, president of the Hewes & Phillips Iron Works; Edwin M. Hall, treasurer of the Jefferson Union Co.; Eugene McSweeney, president of the United States Graphite Co.; Prof. E. J. Houston, co-inventor with Prof. Elihu Thomson of the first successful arc-lighting system; Columbus Dill, known by engineers throughout the country; George Westinghouse, the well known inventor and engineer at the head of the Westinghouse interests; John F. Shearman, perhaps better known by his nom-de-plume, Peter Van Brock; Edwin M. Coryell, for many years consulting engineer for the Cameron Steam Pump Works; James W. Thomson, chief engineer U. S. N., retired; Walter Laidlaw, secretary of the International Steam Pump Co.; H. R. Gilbert, manager of the Continental Works of the National Tube Works Co.; W. F. Crane, member of the family known all over the country as engineers; John Erwood, consulting mechanical engineer and inventor of the various valves and water-tube boiler bearing his name; George Willard, formerly connected with the Murray Iron Works Co.; M. Carels, one of the founders of the firm of Carels Frères; Sir Joseph W. Swan, one of the early inventors of the incandescent electric light; Frank L. Busey, engineer of Buffalo Forge Co.; George N. Nistle, vice-president of the Illinois Engineering Co.; Quimby N. Evans, senior partner of the firm of Evans, Almirall & Co.; Edward B. Denny, past-president of the National Association of Master Steam and Hot Water Fitters; Edwin F. Williams, an authority on steam engines and a prominent designer; John B. Allen, a prominent engineer and salesman, formerly vice-president and general manager of the Allis-Chalmers Co. and later Western sales manager for the Westinghouse Machine Co.; Albert B. Franklin, a well known heating and ventilating engineer; J. H. Millett, president of the Crosby Steam Gage & Valve Co.; T. G. Meier, vice-president and treasurer of the Heine Safety Boiler Co., and Col. E. D. Meier, president of the same company and one of the most eminent mechanical engineers in the country, and Charles A. Moore, president of Manning, Maxwell & Moore and identified with the Shaw Electric Crane Co., the Consolidated Safety Valve Co., the Ashcroft Manufacturing Co., the Hancock Inspirator Co., and the United Injector Co.

⁂

Engineers' Wages

That the wages of engineers are not the same in Wichita, Kan., as they are in Foxboro, Mass., worries one of our contributors in this issue (page 18). He went to the trouble of sending about seventy-five letters to engineers in widely separated parts of the country and found that there is no consistency in the salaries paid engineers in similar sized plants. After all it is not surprising; doctors right in the same city get widely different prices for the same operation (sometimes their fee depends on what the patient is able to stand financially). So it is in all professions and trades (except where unions have artificially fixed the scale of wages); workers are rewarded according to their ability, and their availability. Relative competence makes for differences in wages, and supply and demand have as much influence on the labor market as any other. Mr. Pagett has made an interesting little research into a subject we are all much concerned about, but we do not look for any changes in conditions in consequence of it.

⁂

Central stations in Germany are showing less loss of business, because of the war, than would be naturally expected, according to a report. This would seem to prove that they are a more hardy kind of vegetation than isolated plants. *Auch*, weeds are harder to kill than things you want to raise.

⁂

Someone has said that "while figures do not lie, liars sometimes figure." This is not to cast any reflections on those who have taken part in the discussion of the engine for the Karpen plant (page 27), but to emphasize the possibility of arriving at results which prove one thing, or the contrary, according to the assumptions that are made before, during or at the end of the calculations. One guess is as good as another and neither can be bolstered up with mathematics. It is still a guess, however much it may be concealed in figures to give it an air of truth.

Correspondence

Why Did the Gage Hand Vibrate?

Our six 66-in.x16-ft. return-tubular boilers are connected to a common header from which steam is taken for two 30, 52 and 6½x36-in. cross-compound pumping engines. Between the hours of six and nine in the morning and evening, the hand of the recording steam gage vibrated considerably. This action continued for five days, or until the oiler opened wide the valve to the gage, allowing the hand to vibrate rapidly. When the valve was closed to the normal opening, the vibration ceased and has not occurred since.

We are wondering what the cause of the trouble was, and would be pleased to read what some readers think was the cause.

A. E. ALDRICH.

Newman, Calif.

Engine for Karpen Plant

The article in POWER of Oct. 27 dealing with the Karpen factory plant is well worth the attention of every operating engineer, as it illustrates some of the problems entering into the choice of an engine. However, in the writer's opinion, the results obtained were not quite fair to the compound engine.

Before entering upon that phase of the subject attention is called to the efficiency allowed the generator of the compound unit. It is evident that this machine was of inferior make to show only 90 per cent. efficiency. The writer is fairly familiar with the standard makes and in no case has an efficiency as low as this been encountered when the machine was larger than 75 kw. The correct thing would have been to substitute a better generator.

Then, as regards the extra charge for oil for the compound engine, it would seem that $100 is too much to add. In the yearly report at the end of the article, it was shown that the cost of all the oils used in the entire plant was only $112.64 for six months; surely the oil charge for the simple engine only would not exceed $100 per year. If this be true, then the additional oil used on a compound engine would not exceed $25; for the cylinder oil would be almost the same as on a simple engine, while the engine oil should be approximately the same in either case.

Approaching the question of fuel cost of the two installations, it must, first of all, be understood that in arriving at the solution of the question as to the best unit to install, the steam-heating question must also be considered. It is evident that with the steam heating eliminated, the compound engine would be the one to purchase. But the steam heating complicates the problem and it is necessary to consider its effect on the steam cost.

First, take the simple engine. It is to develop 250 kw. 10 hr. per day for 300 days, with a water rate of 24 lb. per i.hp.-hr., engine efficiency 93 per cent., dynamo efficiency 92 per cent. Then the amount of steam passing through the simple engine hourly during the eight heating months would be

$$\frac{250 \times 24}{0.93 \times 0.92 \times 0.746} = 9404 \text{ } lb. \qquad (A)$$

The B.t.u. passing into the heating coils at a pressure of 16 lb. abs. would be

$$9404 \times 1034.1 = 9{,}724{,}676 \qquad (B)$$

This amount of heat is absorbed by the heating system and should be charged against it. In live steam at a pressure of 140 lb. abs. it is equivalent to

$$\frac{9{,}724{,}676}{1192.2} = 8157 \text{ } lb. \qquad (C)$$

Whether expressed in B.t.u. or in equivalent pounds of live steam, this is the heat the simple engine has supplied the heating system and its cost must be charged against it.

With an evaporation of 7 lb. of water per pound of coal, the latter costing $3 per ton, the charge per hour against the heating system would be

$$\frac{8157 \times \$3}{7 \times 2000} = \$1.748 \qquad (D)$$

Likewise, since the simple engine handled 9404 lb. of steam, the charge against both engine and heating system per hour would be

$$\frac{9404 \times \$3}{7 \times 2000} = \$2.015 \qquad (E)$$

For ten hours per day for eight months the cost would be

$$\$2.015 \times 10 \times 200 = \$4030$$

It is self-evident that the difference between (D) and (E) is the actual cost of the heat used in the simple engine. Thus, per hour, this amounts to

$$\$2.015 - \$1.748 = \$0.267 \qquad (F)$$

Taking up the operation of the compound during the eight heating months it is found that the engine has a water rate of 20.5 lb. per i.hp.-hr. Developing 250 kw., with an engine efficiency of 88 per cent. and a dynamo efficiency of 90 per cent., the steam passing through the engine per hour would be

$$\frac{250 \times 20.5}{0.90 \times 0.88 \times 0.746} = 8674 \text{ } lb. \qquad (G)$$

The heat units given up to the steam-heating coils would then be

$$8674 \times 1034.1 = 8{,}969{,}783 \text{ } B.t.u.$$

Since all the exhaust from the simple engine was to be used, then if the compound engine was to be installed there would not be sufficient exhaust steam. This would necessitate using live steam to make up the difference. Since the simple engine would supply 9,724,676 B.t.u. and the compound only 8,969,783 B.t.u., the difference would be

$$9{,}724{,}676 - 8{,}969{,}783 = 754{,}893 \text{ } B.t.u.$$

Expressed in equivalent pounds of live steam at 140 lb. abs., this would amount to

$$\frac{754,893}{1192.2} = 633\ lb. \qquad (H)$$

The operation of the compound would therefore cause the consumption of not only the steam passing through it, but also of a quantity of "makeup" steam. The total amount per hour would be

$$8674 + 633 = 9307\ lb. \qquad (I)$$

The fuel cost per hour would be

$$\frac{9307 \times \$3}{7 \times 2000} = \$1.99 \qquad (J)$$

Then the cost of steam per hour which should be charged against the compound engine would be

$$\$1.99 - \$1.748 = \$0.242 \qquad (K)$$

Since the engines were to operate for two-thirds of the working year, ten hours per day, under these conditions, the charge against the simple engine would be

$$\$0.267 \times 200 \times 10 = \$534$$

and against the compound engine

$$\$0.242 \times 200 \times 10 = \$484$$

Taking up the peak load of 75 kw., which occurs for three hours per day for 100 days each year, it is necessary to go through the same process. These calculations, simplified, are as follows: Steam passing through simple engine

$$\frac{75 \times 3 \times 100 \times 24}{0.93 \times 0.92 \times 0.746} = 846,395\ lb.$$

Cost of this steam

$$\frac{846,395 \times \$3}{7 \times 2000} = \$181.37$$

Equivalent live steam supplied coils

$$\frac{846,395 \times 1034.1}{1192.2} = 734,153\ lb.$$

Cost of steam for coils

$$\frac{734,153 \times \$3}{7 \times 2000} = \$157.32$$

Steam passing through the compound engine

$$\frac{75 \times 3 \times 100 \times 20.5}{0.90 \times 0.88 \times 0.746} = 780,721\ lb.$$

Equivalent steam furnished heating system

$$\frac{780,721 \times 1034.1}{1192.2} = 677,188\ lb.$$

Amount of live steam that must be added on account of compound engine not supplying enough

$$734,153 - 677,188 = 56,965\ lb.$$

Cost operating compound and heating system

$$\frac{(780,721 + 56,965) \times \$3}{7 \times 2000} = \$179.50$$

Fuel cost operating compound engine

$$\$179.50 - 157.32 = \$22.18$$

Fuel cost operating simple engine

$$\$181.37 - 157.32 = \$24.05$$

Considering the four months where 30 per cent. of the exhaust steam is wasted, the simple engine is using

$$\frac{250 \times 10 \times 100 \times 24}{0.93 \times 0.92 \times 0.746} = 9,404,389\ lb.$$

The cost of the steam passing through the simple engine is

$$\frac{9,404,389 \times \$3}{7 \times 2000} = \$2015.23$$

The equivalent live steam supplied the heating system and used is

$$\frac{(9,404,389 \times 1034.1)}{1192.2} \times \frac{70}{100} = 5,710,078\ lb.$$

Cost of exhaust heating

$$\frac{5,710,078 \times \$3}{7 \times 2000} = \$1223.59$$

Charge against simple engine

$$\$2015.23 - \$1223.59 = \$791.64$$

The compound engine during this time would use

$$\frac{250 \times 10 \times 100 \times 20.5}{0.88 \times 0.90 \times 0.746} = 8,674,678\ lb.$$

Cost of steam

$$\frac{8,674,678 \times \$3}{7 \times 2000} = \$1858.86$$

Charge against compound engine

$$\$1858.86 - \$1223.59 = \$635.27$$

Then the total fuel charge against the simple engine would be

$$\$534 + \$24.05 + \$791.64 = \$1349.69$$

The total charge against the compound engine would be

$$\$484 + \$22.18 + \$635.27 = \$1141.45$$

The summary of total charges would then become

	Simple Engine	Compound Engine
Fixed charges	$1435.92	$1568.00
Fuel	1349.69	1141.45
Extra oil	.....	25.00
Total	$2785.61	$2734.45

So that, even in the face of an excessive depreciation charge, the compound proves more efficient.

The engineer calculated that 25 per cent. of the two total charges would be eliminated by using shavings. This is wrong since both heating and power are under consideration. If power were purchased then the shavings could be used in supplying the live steam to the heating system so that the entire fuel charge against either engine represents coal purchased. But assume that the engineer's contentions are correct, then the fuel for the simple engine would be represented by coal, $1012.27, and shavings, $337.42 Then since the total fuel charge of the compound is $1141.45, this would be divided as follows: Shavings, $337.42; coal, $804.03. This is true as the amount of shavings available is the same regardless of the kind of power. Then the summary becomes

	Simple Engine	Compound Engine
Fixed charges	$1435.92	$1568.00
Coal	1012.27	804.03
Extra oil	.....	25.00
Total	$2448.19	$2397.03

L. H. Morrison.

Dallas, Texas.

The above discussion is interesting as it attacks the problem from a different angle than the method employed by Mr. Ory. The latter figured each machine independently and divided the cost for steam between the engine and the heating system on the basis of the heat units utilized. Mr. Morrison does the same thing for the simple engine. With the compound engine, he supplies the same amount of heat to the heating system by finding the deficiency in the exhaust, reducing it to its equivalent in live steam and charging it, along with the steam actually utilized, against the compound engine.

In the cost of fuel, per year, he finds a difference of $208.24 in favor of the compound engine. By Mr. Ory's method the saving in fuel effected by the use of a compound engine amounted to $67.25. Using the same fixed

charges and reducing the extra oil required by the compound from $100 to $25, Mr. Morrison finds a balance of $51.16 favoring the compound engine. In his figuring Mr. Ory shows a gain of $164.83 for the simple engine.

Although it was not so stated in the article, the oil item of $100 was intended to include additional supplies required. The exact amount to charge is, of course, a matter of judgment, but in the writer's opinion the item should be much nearer $100 than $25. The efficiencies for the compound unit were placed low, as a price $766 lower than for the simple engine indicated light and cheap construction. Naturally, this would result in lower economy and greater depreciation.

An item which would affect the balance considerably, not touched upon in the above discussion, is the cost of the compound engine. A compound unit of equal quality should cost about one-fourth more than the simple unit, or, in round numbers, $15,000. Then reducing the depreciation to the 5 per cent. assumed for the simple engine, the fixed charges are higher by $232 and $364 more than for the simple engine. Raising the efficiencies of the compound engine and generator to those of the simple unit would slightly reduce the fuel cost for the compound, but there would still be a considerable balance in favor of the simple engine.

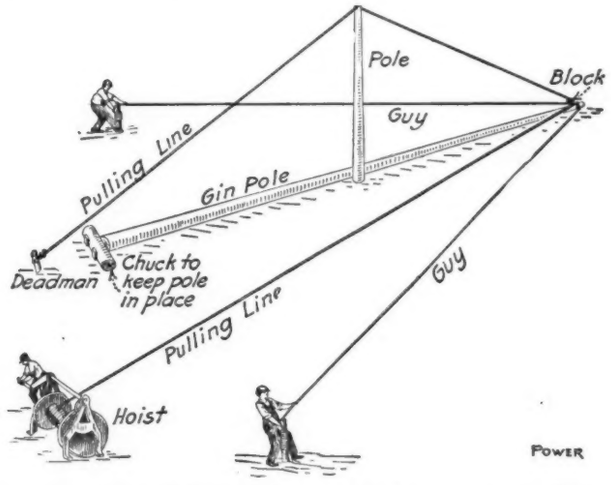
The above figures are, of course, arbitrary, as they are all based on assumptions, but, generally speaking, when practically all of the exhaust steam is used in the heating season and 70 per cent. of it in the summer months, there is little need for a compound engine. The small saving in coal that might be effected will not warrant the additional expenditure usually required for a good compound unit.

THOMAS WILSON.

Chicago, Ill.

Raising a Gin Pole

There are occasional articles in POWER regarding the erection of smoke-stacks, but I have never noticed any information on how to raise a gin pole with which to begin the stack-raising job. Here in Alaska we use from forty-



APPROXIMATE POSITIONS OF MEN RAISING GIN POLE

to sixty-foot gin poles and raise them off the ground without a mast. We require only three men, two at the guys and one at the hoist.

When the pole is laid in place, the guys are put on, a block of wood or a cable at the butt keeping the pole from moving ahead. A single pulley block is fastened at the top. The pulling line runs from the hoist through the block back to a fixed point or dead-man in line with the gin pole. A pole about fifteen feet long, having a small notch cut in one end, is placed vertically under the pulling line about midway of the gin pole. When power is applied and the pulling line tightens up, the pole is raised off the ground. After it is up some distance, the pole under the cable is released and falls, but the hoist keeps on pulling until the pole is up. (The illustration does not show the fixed points in their true relative positions on account of lack of space.)

This is a simple and quick way to raise a pole.

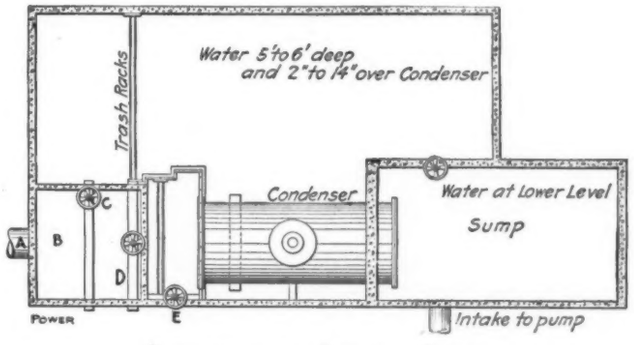
EDWARD M. KEYS, JR.

Chatanika, Alaska.

Novel Condenser Setting

While visiting the La Habra Valley Water Co.'s plant, near Whittier, Calif., I saw what I thought was a good condenser setting.

A surface condenser was set in an enlarged section of



CONDENSER IN INTAKE CANAL

the intake canal into which the water flows by gravity from wells in the hills. The general layout is shown in the illustration. The water enters through conduit *A* into receiver *B*. From there it is bypassed through gate *C* or through the condenser tubes by opening gate *D*, and by adjusting the two gates the flow is regulated.

Gate *E* may be used to drain off the water for cleaning out or repairing the condenser or basin. All the other details are as in the average surface condenser plant. The prime object is, of course, saving power by avoiding handling the cooling water with a pump.

C. R. CLARK.

Anaheim, Calif.

Finding the Value of Coal

The writer encountered a case recently in which there was a possibility of considerable saving if a certain coal could be economically used. His plant is served by two rival roads which will be designated A and B. A good free-burning coal had been obtained on road A, but its unloading switch was so far from the boiler room that it cost about ten cents a ton to haul the coal. As road B could bring coal directly to the boiler-room door, it was desirable to thus obtain the coal and save the additional expense.

After trying several more or less unsatisfactory coals a

coal was found which could be obtained by road B and which, with the same cost per ton on the switch, gave better results by a laboratory test than the coal which had been formerly shipped on road A. Upon testing in the boiler room, however, it clinkered badly and gave a low evaporation. The practical test alone would probably have proved the coal unsatisfactory. As the analysis was good it was decided to experiment further with the coal. In the course of a few days, it was found that by altering the depth of fire carried and the method of firing, the coal could be burned without serious clinkering. The evaporation went up, and this coal has since proved more satisfactory than that formerly used. At the same time, 10c. a ton has been saved on handling.

In this case the plant superintendent acted as his own chemist and he was fortunate in having an engineer who was broad-minded, eager to produce results and to save money for his company.

The writer does not argue that any coal which appears well from a laboratory test can be used economically in regular operation, but a good showing by a coal in the laboratory, if properly considered, will result in an exhaustive test in the boiler room and may be the means of saving much money.

WILLIAM A. DUNKLEY.

Atlantic City, N. J.

Water-Hammer in Blowoff Pipes

In boiler plants where the main blowoff header leads into a catch basin emptying into the city sewer through a small drain, care should be taken to avoid water-hammer. If the basin fills up above the end of the blowoff, the water will flow back into the pipe as it cools slightly; then if another blowoff valve is opened before the water recedes, water-hammer is almost sure to occur. I know of such a case where one man lost his life when a fitting ruptured. Beware of short bends and water in blowoff pipes.

JOHN F. HURST.

Louisville, Ky.

Water End of Pump Was Vapor Bound

In starting four feed pumps in a new power house not long ago, it was discovered that the feed-water heaters were set too low to supply the upper suction-valve chambers of the vertical feed pumps when the water was over 200 deg. F. The erecting and consulting engineers admitted that a mistake had been made, but they were powerless to remedy it. After it had become necessary to cut the steam off the heaters to secure quiet working of the pumps, reducing the feed-water temperature to 150 deg. F., the operating engineers connected a pipe between the upper suction-valve chamber of the vertical duplex feed pump with the return tank, so as to relieve the heater of the high back pressure.

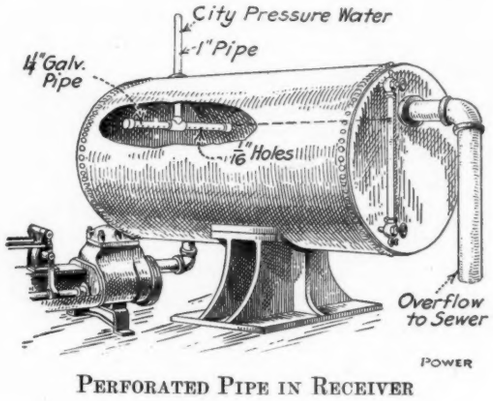
Weaker springs were put on the upper suction valves so that the valves would open and admit water at a lower vacuum than before the change. The vapor which heretofore filled the suction pipe and pump-valve chambers now found an outlet through the vapor pipe. The result was that the pump worked without slamming and the feed-water temperature increased to 210 deg. F.

JACOB R. REZNIEM.

Brooklyn, N. Y.

Oil Skimmer

The illustration shows an oil skimmer which I believe will clear the receiver of most of the cylinder oil. At one end of the receiver is a spray pipe with holes in only one side. City water is turned on when the receiver is



PERFORATED PIPE IN RECEIVER

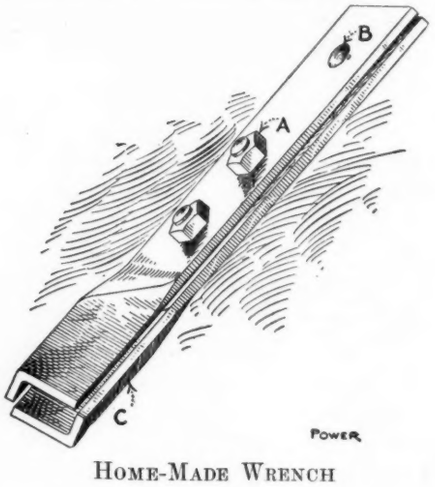
overflowing and the force of the spray skims the oil from the water and drives it toward the overflow and to the sewer. If this is done once a day there will be little or no trouble from cylinder oil.

A. C. WALDRON.

Revere, Mass.

Adjustable Socket Wrench

The illustration shows how a handy adjustable socket wrench may be easily made. One end of two flat bars is formed as shown at *C*. Bolts *A* should be threaded for



HOME-MADE WRENCH

quite a length to afford adjustment. A hole *B* will be found convenient at the top for a bar to turn the wrench. An extension bar may be used to lengthen the wrench when used in a cramped place.

JAMES E. NOBLE.

Toronto, Ont.

Inquiries of General Interest

Common Exhaust Line for Several Engines—Is it good practice to have several noncondensing engines exhausting into one exhaust line?

E. C. P.

It is general practice to have a common exhaust line for several engines, and it works satisfactorily providing the main exhaust line is large enough for handling the exhaust from all the engines without materially increasing back pressure on any of them.

Temperature of Oil Discharged from Step Bearings of Steam Turbines—What temperature is proper for oil discharged from the step bearing of a steam turbine?

B. H. C.

The maximum oil temperature permissible will be determined by the viscosity of the oil for the temperature at which it is discharged. Using a good quality of oil for the step bearings of large vertical Curtis turbines the temperature of the discharged oil is about 150 deg. F., thereby attaining a rise of about 50 deg. F.

Cost of Operating Electric Motor—What would be the cost of operating a 100-hp. motor using current costing 2c. per kw.-hr.?

C. W. R.

One horsepower equals 746 watts, and 100 hp. would equal 100×746 watts, or

$$\frac{100 \times 746}{1000} \text{ kw.}$$

With a motor of 91 per cent. efficiency, the input required for an output of 100 hp. would be

$$\frac{100 \times 746}{1000 \times 0.91} \text{ kw.}$$

and with current costing 2c. per kw.-hr. the cost would be

$$\frac{100 \times 746}{1000 \times 0.91} \times 0.02 = \$1.64 \text{ per hr.}$$

Variation of Water Column for Difference of Temperature—When our boiler is operated at 100 lb. gage pressure, and the temperature of the water in the column and connections is 95 deg. F., the water level shown by the glass gage is 30 in. above the point where the water column connects with the boiler. How much higher would the water level show in the glass gage if the temperature were the same as the temperature of the water in the boiler?

M. C. R.

For 100 lb. gage pressure the temperature of the boiler water would be about 338 deg. F. A cubic foot of water at 95 deg. F. weighs 62.06 lb. and at 338 deg. F. weighs 56.01 lb. For producing the same hydrostatic pressure at the foot of the connection the height of water column would be inversely as the density of the water. Therefore with a density corresponding to the temperature of the boiler water the water level would stand

$$(30 \text{ in.} \times 62.06) \div 56.01 = 33.24 \text{ in.}$$

above the foot of the connection—i.e., it would show about 3¼ in. higher level than with the water in the connections at 95 deg. F.

Obtaining Absolute Pressures from Gage Readings—Why can not the dial of an ordinary Bourdon spring pressure gage be laid off to indicate absolute pressures by direct readings?

C. J. R.

The tube of a Bourdon spring gage is moved by the difference of pressure inside and outside of the tube, and for indicating absolute pressure either the interior or the exterior pressure would have to be constant. As ordinarily constructed the exterior of the tube is exposed to atmospheric pressure, and as this is variable the dial is laid off only for pressures above or below the atmosphere. Hence "0" gage pressure is atmospheric pressure, and as the gage indicates the difference between atmospheric pressure and the internal pressure, then when the internal pressure is greater than atmospheric pressure, as in the ordinary pressure gage, the absolute pressure will be gage pressure plus atmospheric pressure. When the internal pressure is less than atmospheric pressure, as in the case of a vacuum gage, the absolute pressure will be the atmospheric pressure minus the difference of pressure indicated.

Heating Value of Steam at 4 lb. and at 80 lb. Pressure—What is the relative heating value of steam at 4 lb. and at 80 lb. gage pressure when used in a pipe coil or radiator and discharged to a trap?

H. W. J.

Considered with reference to the weight of steam received by a radiator and discharged as condensate at the same pressure, the heating value in each case would be its latent heat of evaporation. The latent heat of a pound of steam at 4 lb. gage pressure is about 962 B.t.u., and for 80 lb. gage pressure it is about 891 B.t.u. Therefore, the heating value of steam at 4 lb. pressure would be $\frac{962}{891}$ times, or have about 7 per cent. greater heating value than the same weight of steam received and discharged as condensate at 80 lb. pressure.

Considered with reference to heating effect from a given amount of radiator surface, the steam of higher pressure would also be at a higher temperature and the radiation of heat would be more rapid, depending on the difference between the temperature of the steam and that of the surrounding atmosphere. With the temperature of the surrounding atmosphere at 70 deg. F. in each case, then as the temperature of steam at 4 lb. gage pressure is about 225 and at 80 lb. gage pressure is about 324 deg. F., for the same radiating surface the relative rate of radiation would be (225 — 70) to (324 — 70), or as 155 to 254—i.e., only about $\frac{155}{254}$ or 61 per cent. as much heat would be radiated from a coil or radiator supplied with steam at 4 lb. as from one supplied with steam at 80 lb. gage pressure.

Factor of Evaporation with Superheater—What would be the factor of evaporation for the performance of a boiler with a superheater where the following averages were observed?

Absolute steam pressure in steam drum	150 lb. per sq.in.
Absolute steam pressure at entrance of superheater	149 lb. per sq.in.
Absolute steam pressure at outlet of superheater	147 lb. per sq.in.
Temperature of steam at outlet of superheater	478.5 deg. F.
Temperature of feed water	100 deg. F.

W. F.

Considering the superheater as a part of the boiler, the factor of evaporation of the boiler should be based upon the pressure and temperature of the steam at the outlet of the superheater, viz.: 147 lb. absolute and a temperature of 478.5 deg. F. The temperature of dry saturated steam at 147 lb. absolute is 356.9 deg. F., therefore a temperature of 478.5 deg. F. would represent

$$478.5 - 356.9 = 121.6 \text{ deg. of superheat.}$$

Referring to the Marks and Davis steam tables, the total heat of a pound of steam at 147 lb. absolute when superheated 120 deg. F. is 1259.4 B.t.u. above 32 deg. F., and when superheated 130 deg. F. is 1264.5 B.t.u. By interpolation between these values, the total heat per pound of steam at 147 lb. absolute, superheated 121.6 deg. F., would be

$$1259.4 + \left[\left(\frac{1264.5 - 1259.4}{130 - 120}\right) \times (121.6 - 120)\right] = 1260.21 \text{ B.t.u.}$$

so that with feed water at 100 deg. F. each pound of feed water evaporated into steam at 147 lb. absolute and 478.5 deg. F. would receive

$$1260.21 - (100 - 32) = 1192.21 \text{ B.t.u.}$$

The latent heat of evaporation of water from and at 212 deg. F. being 970.4 B.t.u. per lb., the factor of evaporation under the condition stated would be

$$\frac{1192.21}{970.4} = 1.2286$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Engineers' Study Course

Problems in Power-Plant Design--XII

WATER SUPPLY AND FIRE PROTECTION, CONTINUED

The quantity of water required and the horsepower necessary for pumping it from the river to the reservoir have already been approximated, but in designing the pumping outfit it will be necessary to go over the matter a little more carefully.

The maximum supply was based on that required for condensing and was taken as 7000 lb. approximately per min. This made an allowance for the exhaust from auxiliaries and assumed that the total amount of steam supplied to the engine would be discharged into the condenser.

In the final arrangement of the plant it was decided to utilize the exhaust from the auxiliaries in a feed-water heater, and in making the more accurate computation we will make use of Table 1 in last lesson, which takes cylinder condensation into account. Thus

$$\frac{670 \times 15 \cdot 35}{60 \times 8.3} = 707 \textit{ gal. per min.}$$

will be required. It will be remembered that 670 hp. was required for the entire plant; 15 is the water rate minus 10 per cent. and 35 is the pounds of water required to condense a pound of steam.

In the present case the surface of the river is 50 ft. below the power house, so it will be necessary to locate the pump in a special building at such an elevation that the total suction lift will not exceed 15 ft. With this arrangement a motor-driven centrifugal pump would seem to be well adapted to the conditions presented. Such a machine requires but little attention, it may be shut down from the engine room, and power is easily transmitted from the central plant. There is little choice in a case of this kind between the triplex plunger pump and a centrifugal, but the latter is simpler in construction and may be driven by a direct-connected motor without the use of gears or belts.

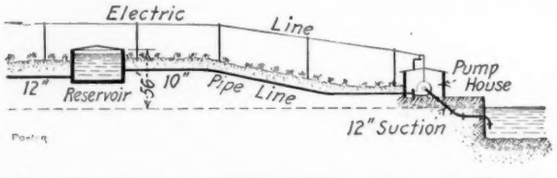


FIG. 1. PUMPING WATER SUPPLY FROM RIVER

In the design of the pumping plant the first step is to find the size of main between the pump and the reservoir, which is usually fixed by the relation between the saving in cost of pipe and the increased cost of pumping against a greater head. A large pipe reduces the friction and therefore saves in pumping expenses, but it costs more to install. Under average conditions a velocity of 2 ft. per sec. for pipes up to 10 in. in diameter, and a velocity of 3 ft. for larger sizes, seem to give about the right balance between the cost of pipe and that of pumping.

A table of velocities and friction heads for water pipe shows that a 10-in. pipe will discharge 750 gal. per min.

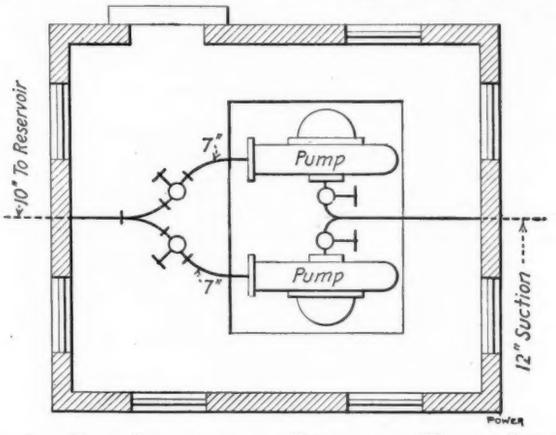


FIG. 2. TWO CENTRIFUGAL PUMPS ON WATER SUPPLY

at a velocity of 3.06 ft. per sec., and with a friction head of 0.18 lb. per in. or

$$0.18 \times 2.3 = 0.41 \textit{ ft.}$$

for each 100 ft. For the entire run of 500 ft. this gives

$$0.41 \times 5 = 2.05 \textit{ ft.}$$

As the run is of comparatively short length, a velocity of 3 ft. per sec. will be assumed and a 10-in. pipe used. Doubling this friction head to include bends and valves, and adding 6 ft. for the elevation of the reservoir, gives a total lift of

$$50 + 4 + 6 = 60 \textit{ ft.}$$

to be pumped against. Assuming a slip of 30 per cent. the pump must have a rated capacity of

$$707 \div 0.7 = 1010 \textit{ gal. per min.}$$

under a head of 60 ft. A table of centrifugal-pump capacities states that a pump with a 21-in. impeller and a 7-in. discharge outlet will deliver 1058 gal. per min. under a 60-ft. head at a speed of 655 r.p.m. This is the size that should be used in the present case. Assuming an efficiency of 60 per cent., the horsepower of motor for driving it will be

$$\frac{707 \times 8.3 \times 60}{33{,}000 \times 0.6} = 18$$

say, 20 hp. to make it a standard size. Two pumping units are provided, Fig. 2, and with the pipe sizes used they may be operated together when a large supply of water is wanted, as in case of fire.

RESERVOIR

It was assumed in a previous article that the reservoir should have a storage capacity equal to that required for a day's run, which we will take as a maximum of 8 hr. and which calls for

$$707 \times 60 \times 8 = 339{,}360 \textit{ gal.}$$

A reservoir 50 ft. in diameter by 30 ft. in height will give an excess capacity of about 100,000 gal. By duplicating

the pumping machinery it would probably not be necessary to provide so large a storage reservoir, because in case of a breakdown to both of the pumps the engine could be run noncondensing, and a storage capacity of half the above would be ample for boiler feeding and fire purposes during a temporary shutdown of the pumping plant.

It will be sufficient to provide a concrete reservoir 50 ft. in diameter by 15 ft. in depth, extending 6 ft. above grade. This will make it possible to drain it into the main sewer, and also, under normal conditions, there will be sufficient head to cause the water to flow to the pumps and to the receiving tank and boilers by gravity. Diagrams showing the general arrangement of the pumping machinery, pipe line and reservoir are given in Figs. 1 and 2.

Fire Protection

A system of fire protection consists of two parts—one for outside service, made up of hydrants and their underground connections, and a sprinkler system for inside protection. The rules for laying out a system of this kind vary somewhat in different localities, and the proposed system should be submitted to the fire underwriters for that district before its installation. The following data are general in character and correspond to average conditions.

Water Supply

There should be two independent supplies, one of which should be automatic and capable of furnishing water under a heavy pressure. Common sources of supply are a pond, river or large reservoir from which the water is drawn by a pump, city mains, and elevated or pressure storage tanks. A combination of any two of these will usually give sufficient protection.

Pumps

Standard fire pumps have capacities of 500, 750, 1000 and 1500 gal. per min. The 1000-gal. size is the one most frequently used, although many 750-gal. pumps are installed. The 500-gal. size is only for use in the smallest plants. It is more common to have two smaller pumps than a single large one of 1500 gal. capacity. The pumps most frequently used for this purpose are the direct-acting steam pump, rotary pump and electrically driven pumps, while turbine or centrifugal pumps are also employed to some extent. All of these pumps are made in standard sizes for this purpose. The pumps should always be duplicated and so connected that they may be run either singly or together.

Outside Protection

Hydrants are commonly placed from 150 to 200 ft. apart and provided with two to four hose outlets each, three being the standard. They should be located about 50 ft. from the buildings they are to protect, depending somewhat upon the height. There are two general methods employed for supplying the hydrants, known as the "loop" system and the "dead-end" system; they are sufficiently described by their names. The former is usually preferable, as smaller mains may be used, the supply coming from both directions. The number of hose outlets supplied from mains of different sizes are given in Table 3:

TABLE 3. NUMBER OF HOSE CONNECTIONS

Size of Main, In.	Length of Main, Ft.	Number of Hose Outlets on "Dead-End" System	Number of Hose Outlets on "Loop" System
6	250	3	6
6	500	2	4
4	250	6	10
8	500	4	8
8	1000	3	..

A two-way hydrant should have a 5-in. gate and three- and four-way hydrants have a 6-in. gate. While the largest mains given in the table are 8 in., large plants will often call for 10- and 12-in. mains.

Sprinkler Systems

The spacing of the sprinkler heads will depend somewhat upon the construction of the building. For standard mill construction, the spacing given in Table 4 may be used, with one line of sprinklers in the center of each bay. Pipe sizes are given in Table 5.

TABLE 4. SPACING OF SPRINKLER HEADS

Width of Bay, Ft.	Distance Between Sprinkler Heads, Ft.
6 to 8	12
9	11
10	10
11	9
12	8

TABLE 5. PIPE SIZES FOR SPRINKLER SYSTEM

Pipe Size, In.	Number of Sprinklers	Pipe Size, In.	Number of Sprinklers
1	2	3	36
1¼	3	3½	55
1½	5	4	80
2	10	5	140
2½	20	6	200

When an elevated tank forms one of the supplies for a sprinkler system it should have a capacity of 10,000 to 20,000 gal., 15,000 being about the average.

Pressure tanks may be made somewhat smaller on account of the higher pressure carried. A tank of 6000-gal. capacity corresponds to one of 10,000 of the elevated or gravity type. In practice it is customary to use two or more smaller pressure tanks rather than a single larger one on account of the expense, 8000 to 9000 gal. being

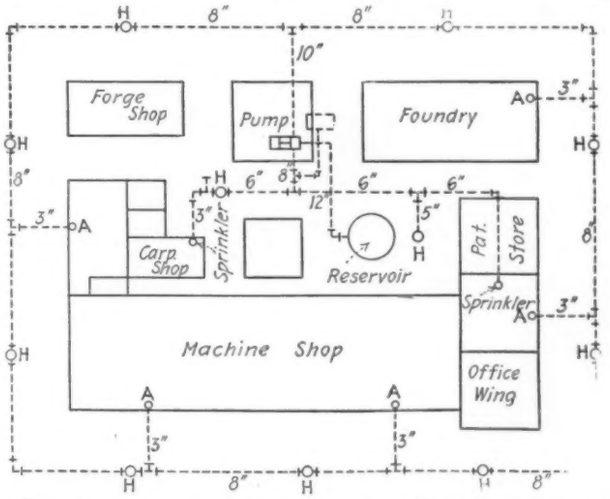


Fig. 3. Layout of Hydrants and Outside Piping

about the limit. In general, tanks of this kind are located above the sprinklers, kept about two-thirds full of water and subjected to a pressure of 75 lb. per sq.in., which insures a pressure of 15 lb. when the tank is empty. Both elevated and pressure tanks may be made to connect with a general system of fire mains, from which the sprinkler system takes its supply, provided there is sufficient head to maintain a minimum pressure of 15 lb. at the highest sprinkler heads.

According to Table 4, the following number of sprinklers will be necessary in the rooms to be protected: Office, 40; drafting room, 40; pattern shop, 40; pattern storage, 50; carpenter shop, 24; paint shop, 6; a total of 200.

Assuming that 60 sprinkler heads will require 250 gal. of water per min., the total requirements for one hour for this purpose will be

$$\frac{200 \times 250 \times 60}{60} = 50{,}000 \ gal.$$

which is only about one-third the capacity of the storage reservoir and therefore well within allowable limits.

The general layout of the hydrants and outside piping is shown in Fig. 3. The loop system is employed for the

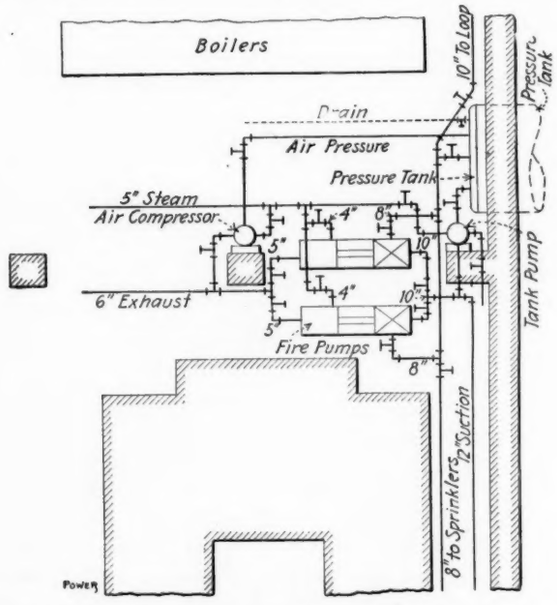


FIG. 4. ARRANGEMENT OF WATER-PRESSURE EQUIPMENT IN POWER HOUSE

outer system of hydrants, with a dead-end supply for the sprinklers and two yard hydrants as indicated.

Inside standpipes, with hose connections, are provided in the machine shop, office wing, foundry and carpenter-shop storage at the points marked *A* on the plan. While an 8-in. loop has a capacity of but eight hose outlets, it is assumed that not more than this number will ever be in use at one time, although there are 9 three-way hydrants on the line.

The arrangement of the pressure equipment in the power house and the various pipe connections are shown in Fig. 4. A pressure of 100 lb. per sq.in. is constantly maintained on the system for automatic sprinkler supply by means of a pneumatic tank having a capacity of 6000 gal. With the tank two-thirds full and the air space above it subjected to this pressure, there will be at least 15 lb. upon the highest sprinklers when the tank has discharged its entire contents.

The tank is filled by means of a special pump, indicated in the drawing, which should be arranged by means of a float valve to maintain the normal water line automatically and thus offset the effect of any leakage in the system. The pressure should also be maintained automatically by means of a compressor actuated by changes in the system.

Two 1000-gal. direct-acting steam pumps are provided. While one is furnished as a relay, the pipe connections are such that they may be operated together in case of emergency. A pump of the type and capacity used will supply four standard fire streams and will require about 150 boiler-horsepower for operating it.

Scientific Boiler Feeding

By E. W. NICK

It is well known that it is impossible to quickly change the intensity of furnace fires and the rate of boiler feeding with every change of load. When the load changes there should be a corresponding change in the rate of feeding, which should be slow enough to allow a gradual and economical change in the furnace fires.

There are advantages obtained by lowering the water level to secure greater steaming capacity for peak and overloads, and raising it during subnormal and no loads to save heat energy. A continuous feed and a scientifically varied water level are desirable features to obtain by any method of feeding.

When a demand for an additional supply of steam occurs, it is not necessary to immediately increase the supply of feed water. Part of the water already within the boiler and at boiler temperature can be evaporated into steam and this process may continue until the water has dropped to the lowest permissible level. Conversely, when the demand for steam falls off, it is not necessary that the amount of feed water be simultaneously decreased. On the other hand, the amount of water in the boiler can be increased so that the heat which would otherwise be lost is saved and utilized for heating up additional feed water.

Suppose, for example, that the load on a boiler suddenly increased by 100 per cent. If the rate of feeding water were increased at the same time by the same amount, then the furnaces would at once have to generate 100 per cent. more heat in order to keep up the steam pressure. This cannot be done, and therefore the steam pressure drops somewhat

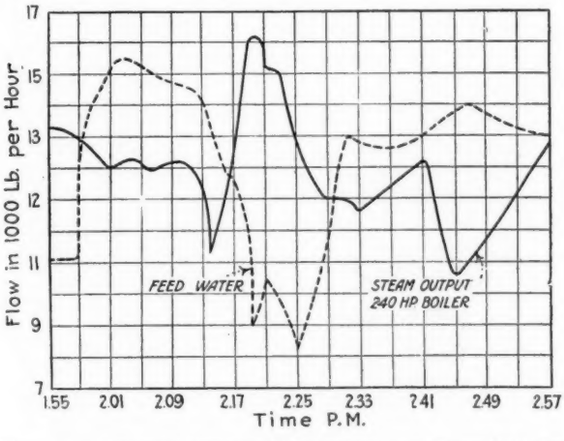


FIG. 1. SIMULTANEOUS READINGS OF FEED-WATER FLUCTUATIONS AND STEAM OUTPUT

and the heat stored in the water is called upon to make steam. Obviously, the last thing to do under such circumstances is to inject a large volume of cold water into the boiler.

If the rate of feeding does not increase when the load increases, then the additional feed water need not be heated and the momentary load on the boiler is increased by only 80 per cent., since the amount of heat required to heat the feed is about 20 per cent. of the total. If the feed water were cut off when the load jumps 100 per cent., then the momentary overload amounts to but 60 per cent.

For high economy, all the boilers in a battery should operate with the load evenly distributed. The efficiency of a boiler falls off gradually as the load is increased and rapidly as the load decreases below normal. It is important that all boilers of a battery work at uniformly high capacities.

Suppose that the five boilers of a battery are working at five capacities and delivering a total of 75,000 lb. of steam per hour with a total battery efficiency of 69 per cent. If the boilers were worked at a uniform high capacity, each of the five boilers would generate exactly one-fifth of the steam and the average battery efficiency would be 72 per cent., or a net gain of 3 per cent.

The unequal distribution of load between the boilers of a battery is caused by differences in condition of fire, of coal, grade of firemen or condition of the stoker, the draft pressure, condition of setting as to leaks, condition of boiler surface as to soot and scale, the position and condition of the dampers, and to the rate of feeding the water.

If a feed-water regulator is so designed that the feed valve cannot assume an intermediate position on light loads, the valve will be closed for long periods and open for short periods. On heavy loads the valve will be wide open for long periods, thus causing a fluctuating steam output and failing to feed in proportion to the rate of evaporation.

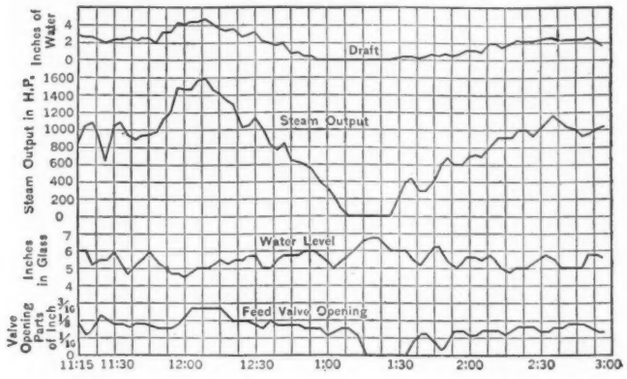


FIG. 2. SHOWING LOAD ARTIFICIALLY VARIED FROM ZERO TO 270 PER CENT. CAPACITY

When feeding by hand regulation, the water tender cannot follow a fluctuating load and at the same time make the proper allowance for the influence of the load and the steam pressure on the height of water observed in the gage-glass. A steam flow meter on each boiler to guide the firemen or stoker attendant has proved successful in regulating individual boiler loads, but hand feed causes wide and misleading fluctuations in steam-flow meter readings. The steam delivery and flow meter reading may be reduced from a heavy overload to practically zero load by the sudden injection of a large volume of cold water. This is illustrated by the curves of Fig. 1, which show simultaneous readings of the feed water and the steam output of a boiler forming one unit of a battery on which there was a constant load, the fireman relying on the steam gage and water column as a guide in regulating the feed water. Under such conditions the advantages resulting from the use of steam-flow meters cannot be realized because the readings cannot be used as a guide to regulation.

The water tender and fireman often work at cross purposes. The fireman assumes that the pressure gage and steam-flow meter readings indicate the boiler and furnace load and the rate at which heat is being absorbed from the furnace by the boiler, whereas the accuracy of the readings may be destroyed and their utility nullified by improper feed.

If every boiler were fed continuously while under load, and if at the same time the water level were varied inversely with the load, this trouble would disappear and all boilers would receive a share of the feed in proportion to the furnace load. If the steam delivery of a boiler, as indicated by the flow meter, is too low, it is corrected by speeding up the stoker, cleaning the fires, opening the dampers and regulating the air supply; then the increased heat generated causes an increased steam delivery, which in turn causes the proper increase in feed supply.

A feed-water regulator should make the rate of feeding dependent upon the furnace load, and so long as each furnace of a battery generates its share of the heat, each boiler of the battery will receive its share of the feed water and genrate its share of the steam.

To meet the foregoing requirements an automatic boiler feed regulator should have the following characteristics: On light loads the water level should be high, so that the boiler stores a maximum amount of water and heat. Conversely on heavy loads, the water level should drop, the heat of the furnace being used for evaporating water in the boiler and not heating cold feed.

To secure this fall in water level, the feed valve should close off the feed somewhat, when the load suddenly increases, thus increasing the heat available for evaporating the water already admitted. However, as the water level falls due to evaporation, the regulator must increase the rate of feed until the amount being fed equals the amount being evaporated.

With a sudden decrease in load, the regulator must not decrease the feed until the water level has risen to the maximum and should even open up the feed valve to rapidly inject cold water, so as to absorb the heat which would otherwise be uselessly generated by the furnace. After the water level has reached the maximum permissible height, the feed must be decreased or shut off. Finally, the regulator should be reliable and automatic so that when the load is removed from the boiler the feed water will be shut off.

That these conditions are not impossible of accomplishment with an automatic device is evident from Fig. 2. These readings were taken on a boiler whose load was intentionally varied from zero to 1600 hp., corresponding to almost 300 per cent. rating. The maximum steam output is accompanied by the minimum water level, followed by a rising water level as the load decreased and a maximum water level at the minimum output. The feed-valve opening does not reach the maximum until some ten minutes after the first peak, showing how the water in the boiler is allowed to evaporate down to the minimum level before the feed valve opens to compensate for the increased load.

Similarly, while the load fell to zero at 1:10, the feed valve did not close until some ten minutes later and only after the water level had reached the maximum permissible level and cold water had been pumped into the boiler, so as to store and save heat.

Another proof of the practicability of this method of feed is shown by Fig. 3. This covers readings on the boilers of the Municipal lighting plant, Jacksonville, Fla. The load varied from 1000 to 4000 kw. The water and load lines have the same general shape, indicating that the feed is in proportion to the load. As with the previous chart, however, the feed does not respond to a change in load until the thermal capacity of the boiler has been utilized.

The first example occurred at 4 o'clock, when the load suddenly dropped from over 2000 to just over 1000 kw. This drop in load, instead of causing a decrease in the rate of feed, was accompanied by a rise in the rate of feed from 60,000 to 75,000 lb., the additional water thus pumped into the boiler saving and storing heat. After 4:10 the boilers were obviously filled to the highest permissible level and the rate of feed fell off. The constantly increasing load from this time up to 6 o'clock is accompanied by a corresponding increase in the rate of feed. At the first peak of the load, occurring at 6 o'clock, the amount of water fed to the boiler fell from about 86,000 to 80,000 lb., indicating how this method of feeding helps to carry peaks. At 7:10, when the load went up again to the maximum, the rate of feed fell from 77,000 to 70,000 lb., not increasing again until the peak had persisted for some time, when the water level had fallen and it was necessary to increase the rate of feed to prevent the level from going below the minimum. L. E. Murphy,

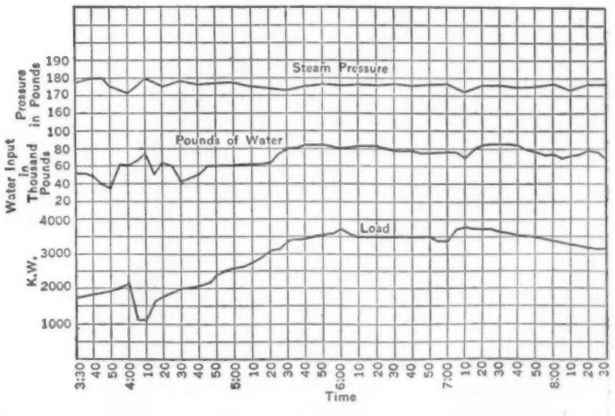


FIG. 3. PERFORMANCES OF FEED-WATER REGULATOR AT MUNICIPAL PLANT, JACKSONVILLE, FLA.

chief engineer of the plant, states that "Our fuel consumption goes up 4 to 5 per cent. for a given kilowatt output when the regulators are not in use."

From the foregoing it is obvious that a continuous-feed regulator makes it possible to use a smaller feed line, smaller valves, and smaller boiler feed pumps for a given boiler horsepower output, or it permits forcing of the boilers without the usual increase in size of lines, fittings and pumps. This is true because the control valve does not close unless the boiler is shut down, and furthermore the valve maintains an intermediate position, so that water is continuously fed to the boiler. As a result, the valve is not called upon to open to

its full extent and is operating far below its maximum capacity. On new installations the saving in the cost of fittings covers a large part of the cost of such a regulator. As boilers are driven at higher and higher loads by the use of mechanical draft and stokers, greater feed capacity is needed and this is amply provided by a suitable system of regulation.

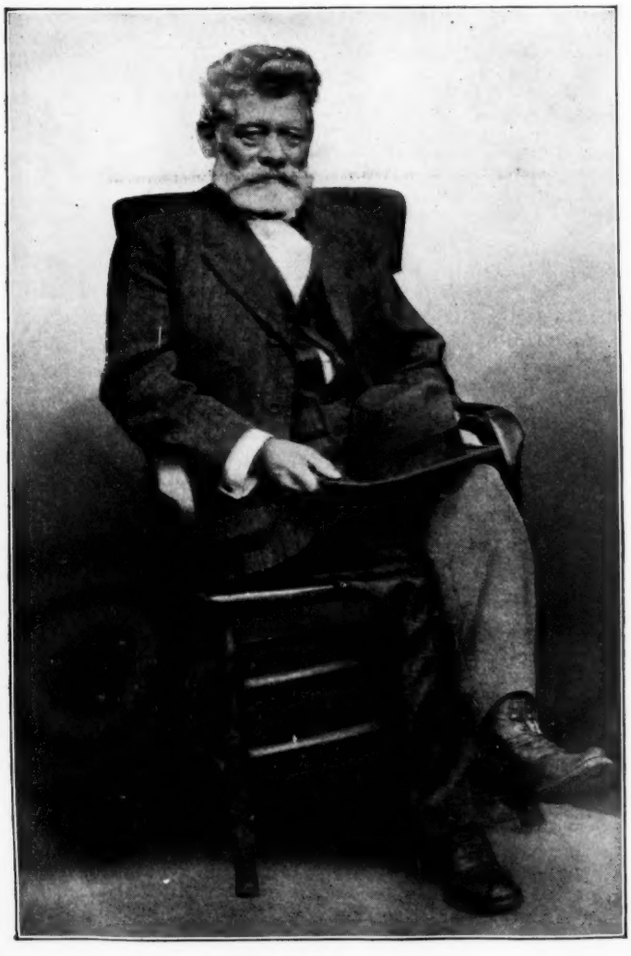
When the rate of feeding varies spasmodically, with consequent variations in the steam delivery, the temperature of superheat also varies through a wide range. The hot gases flowing over the superheater tubes transmit to them a practically constant amount of heat, so that if the steam delivery is suddenly decreased by injecting a large volume of cold water, there is a sudden rise in steam temperature. With proper regulation of feeding there are no sudden or spasdomic variations in the feed, hence no spasmodic variations in the steam delivery; consequently, undue fluctuations in steam temperature produced by the superheater are prevented.

With open feed heaters the efficiency is increased when the rate of feed is even and not subject to wide variations. If the demand for feed water is large, due to excessive feed-valve opening, the water level in the storage space falls low and the float-operated makeup valve opens wide, introducing an excessive amount of cold makeup water with a resulting decrease in temperature. On the other hand, if the feed valves are closed too far, the makeup water is shut off, due to the high level of the water in the storage space, and steam may be wasted to the exhaust. Furthermore, if the feed valves remain closed very long the water in the heater overflows to the sewer and wastes both heat and water.

OBITUARY

FRED ULRICH

Fred Ulrich, general sales manager of the Vilter Manufacturing Co., Milwaukee, Wis., died Dec. 10, at his home, 2720 McKinley Boulevard, Milwaukee, after a short illness.



FRED ULRICH

Mr. Ulrich was born in Apolda, Thueringen, Feb. 19, 1852. He studied in the Gymnasium in Apolda, was graduated from the Royal Institute of Technology in Chemnitz, Saxony, and later from the Polytechnic Institute in Karlsruhe.

In the capacity of mechanical engineer he was engaged by several large concerns in Germany for the design, sale and supervision of large machinery installations in the Russian Empire, Finland, etc. He also traveled extensively in Italy and other countries on the Continent.

In 1882 he came to America and was connected with concerns in Cincinnati, St. Louis and Chicago, and in 1885 assumed the position of chief engineer of the Weisel & Vilter Manufacturing Co., now the Vilter Manufacturing Co. In 1888 he became a stockholder and director, and later general sales manager.

During his 29 years' continuous connection with the company he aided materially in developing the business to one of the largest establishments of its kind. In the performance of his duties he visited a great many of the ice-making and refrigerating plants in the United States and Mexico, and his wonderfully retentive memory enabled him to accurately recall small details years afterward. In the solution of all problems his highly trained, keen and observant mind was of invaluable assistance. He was thorough and conscientious in all business matters, always actuated by a high sense of honor and justice, and while generally inclined to be serious, he had flashes of dry humor which disclosed his deep insight into men and affairs. His demise is a distinct loss to his associates and the refrigerating world.

Mr. Ulrich is survived by Mrs. Ulrich, two daughters and a son.

TRADE CATALOGS

American District Steam Co., N. Tonawanda, N. Y. Bulletin No. 133. Atmospheric System of Steam Heating. Illustrated, 30 pp., 6x9 in.

American Boiler Life Co., 19 N. Market St., Boston, Mass. Pamphlet. "The Scientific Treatment of Steam Boilers and Boiler Feed Water." 8 pp., 5x8 in.

The Hoppes Mfg. Co., Springfield, O. Catalog No. 60. Feedwater heaters, purifiers, steam separators, V-Notch water meters, etc. Illustrated, 80 pp., 6x9 in.

The Direct Separator Co., Syracuse, N. Y. Catalog. Direct flanged steam fittings, American and U. S. 1915 standard, Sweet's separators, etc. Illustrated, 44 pp., 4½x7 in.

The Industrial Instrument Co., Foxboro, Mass. Bulletin No. 86. Foxboro differential recording gages and orifice meters for gas. Illustrated, 20 pp., 8x11 in. Bulletin No. 91. Foxboro thermometers and thermographs. Illustrated, 52 pp., 8x11 in.

Builders Iron Foundry, Providence, R. I. Bulletin No. 84. The Venturi meter for gravity mains, pump discharge lines, refrigerating plants, etc. Illustrated, 36 pp., 6x9 in. Bulletin No. 85. Venturi hot water meter for boiler feed, etc. Illustrated, 20 pp., 6x9 in.

BUSINESS ITEMS

The National Belt Dressing Co., 220 Broadway, New York, is placing "National" belt dressing on the market.

The pipe insulation contract for the new Utah State Capitol at Salt Lake City, for which R. K. A. Kletting was the architect, and Jas. C. Stewart Co., contractors, was recently awarded to the H. W. Johns-Manville Co., 41st and Madison Ave., New York.

Due to the death of Quimby N. Evans, the copartnership heretofore existing between Q. N. Evans, J. A. Almirall and W. C. Adams, has been dissolved and the corporation of Almirall & Co., Inc., No. 1 Dominick St., New York, has succeeded to that business.

The Goulds Manufacturing Co., manufacturer of triplex, centrifugal, hand and spray pumps, Seneca Falls, N. Y., has just opened a new office in Atlanta, Ga. The office will be located in the Third National Bank Building and will be in charge of Mr. O. B. Tanner, district manager.

A booklet which will interest every man seeking improved boiler results has just been published by the American Boiler Life Company, 19 North Market St., Boston, Mass. It tells things about scale removal, about the prevention of scale and pitting and foaming that are not only interesting but instructive. Copies are mailed on request. The title of the booklet is "Steam Boilers and Boiler Feed Water."

The Mesta Machine Co., of Pittsburgh, Penn., has recently acquired the rights from the Stumpf Una-Flow Engine Co., of Syracuse, N. Y., to build the Stumpf Una-Flow type of engine in the United States. The agreement not only gives the Mesta Machine Co. the patent rights of Professor Stumpf, but includes the use of the knowledge gained by the practical experience, during the past five or six years, of European builders of Stumpf engines. The large number of engines of this type in operation in Europe gives conclusive proof of its superiority in regard to simplicity, economy, etc.